

Chapter 7

Responding to needs: institutions, incentives and finance for future health R&D

This Report has highlighted a set of major challenges to global health at the end of the 20th century: an unfinished agenda of overcoming avoidable maternal and childhood conditions; a continually changing threat from microbes; rapidly emerging epidemics of noncommunicable diseases and injuries; and an acute shortage of data and knowledge to inform health policy and to combat inefficiencies and inequities in health systems. These challenges will place governments and health service providers under considerable strain, particularly in low-income and middle-income countries. And they will test, perhaps more than ever before, the capacity of the international health R&D community to respond with timely and appropriate solutions.

Yet that R&D community—a loose “system” made up of investors, research networks and research institutions in every specialty—is currently falling short of its potential to rise to these challenges. As the previous chapters have shown, the distribution of resources and effort across the spectrum of health problems appears to reflect uneven advocacy and special pleading rather than rational and coordinated responses to need. Some work is duplicated; significant gaps remain; and dispersion of resources constrains capacity to focus resources on the completion of high-priority R&D efforts.

At the crudest level, it is clear that the health needs of poor populations are receiving inadequate attention. The allocation of R&D resources in both public and private sectors reflects the preoccupations of the established market economies, with as little as 5% of total R&D resources being devoted to the health needs of developing countries where 90% of the world's disease burden is carried (Annex 5). The unevenness of this distribution appears to have persisted for some time, as the Commission on Health Research for Development observed a similar pattern when it began work almost a decade ago (Commission on Health Research for Development 1990). It is, of course, important to question the implicit assumption that these health problems are qualitatively different from those of the industrialized world, particularly as the distinction is being gradually blurred by demographic and epidemiological changes. However, in practice there are important distinctions. In particular, the responses that are appropriate to the emerging epidemic of noncommunicable diseases in developing countries must necessarily be different. If resource-poor countries are to provide equitable health services for their populations, they need to develop more cost-effective solutions for these diseases than those deployed in the rich countries.

The bias away from the needs of poor populations is exacerbated by the structure of incentives within the international market for researchers. The vast majority of high-quality scientists are drawn away from the areas of greatest need in the low-income and middle-income countries by the attractions of good facilities, easier links with their colleagues and better rewards for their efforts in the established market economies.

In the Committee's view, obstacles such as these are hampering the effectiveness of the overall R&D effort. Yet certain limited changes could, we believe, greatly enhance the prospects for responding to global needs. This chapter sets out some of the key problems and puts forward a number of realistic and practical proposals which, we argue, could help to harness R&D for international public good in a climate of restricted resources. Before discussing these proposals, however, we begin with a brief descriptive background on the current structure of the international health R&D system.

7.1 The international health R&D system

Health researchers and those who fund them are a highly diverse group. In the simplest scheme, the major players in the health R&D community may be divided into those who *do* research—the operational level—and those who *finance* research—the resource allocation level. Within each of these two broad categories there are further groupings which we set out below. The system is shown graphically in Figure 7.1.

7.1.1 The operational level of R&D

This consists of:

- **The health service providers** which, while rarely conducting any R&D directly, are inextricably linked with health research because they are the source of information about R&D needs, the end users of R&D products and the focus of most clinical research involving human subjects;
- **The institutions**, both discrete and linked into functional networks, that conduct R&D. At national level, these include universities, private institutes, government institutes, health care settings and the pharmaceutical industry. At the international level, there are

internationally supported institutions and operational networks such as WHO collaborating centres, the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B), and the Instituto de Nutrición de Centro América y Panamá (INCAP). Annex 6 discusses the history and potential of international institutions (using ICDDR,B as an example), and points to how it is possible to gain high productivity in such a context.

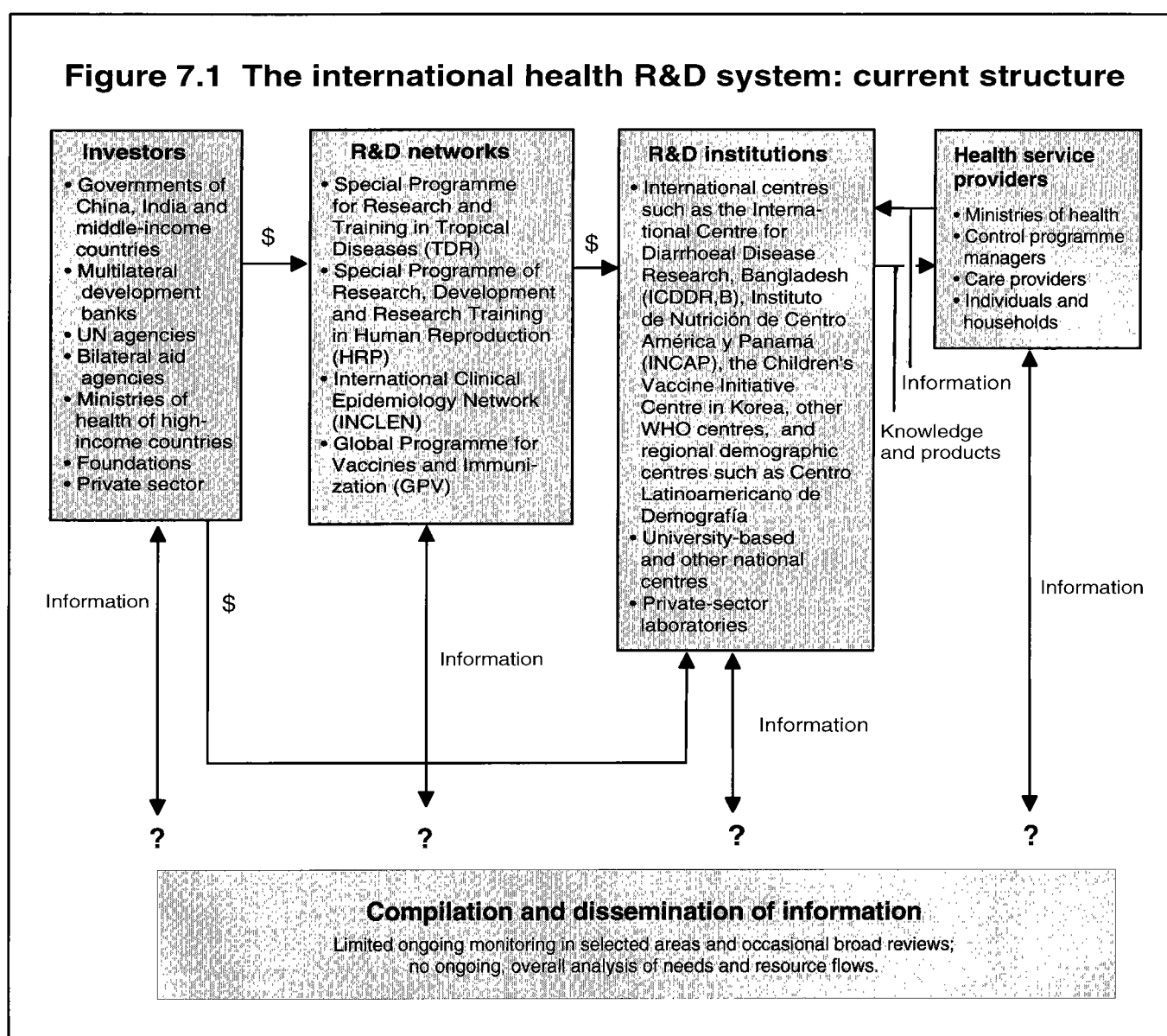
7.1.2 The resource allocation level of R&D

This consists of two broad subgroups: R&D networks and other investors. These diverse groupings are summarized here; greater detail on individual bodies and

programmes and their investment levels can be found in Annex 5. The main groupings are as follows:

- **Specific international R&D networks and programmes** that are charged with the responsibility of investing in focused R&D areas by their sponsors. These include certain special programmes of R&D located at WHO's headquarters in Geneva and supported by a number of international investors: the Special Programme for Research and Training in Tropical Diseases (TDR), and the Special Programme of Research, Development and Research Training in Human Reproduction (HRP), together with the Global Programme for Vaccines and Immunization (GPV). They also include the International Clinical Epidemiology

Figure 7.1 The international health R&D system: current structure



Network (INCLEN) and the International Health Policy Programme (IHPP).

- **Investors in R&D.** This highly diverse group includes public bodies, private foundations and nongovernmental organizations and operates at both national and international level. Some key groups of investors are:
 - (i) the governments of the established market economies, through their research councils, national institutes, ministries of health and official development assistance programmes and, in the cases of a few countries such as Canada and Sweden, their specialized development research agencies; and regional bodies such as the European Commission;
 - (ii) the governments of the middle-income countries, such as Brazil, Mexico, South Africa and Thailand; and large low-income countries, notably China and India, as well as the governments of selected other low-income countries with an interest in health research. As with (i) above, decision-makers may be within national research councils and/or ministries of health;
 - (iii) the UN agencies. As a specialized agency for health, WHO has a mandate in its constitution "to promote and conduct research in the field of health". Other UN agencies and funds involved in health research to varying degrees include the UN Population Fund, the UN Development Programme, UNICEF, the Joint UN Programme on HIV/AIDS and the Subcommittee on Nutrition of the Administrative Committee on Coordination;
 - (iv) the World Bank and regional development banks, which have given increased attention to health in recent years, and which are also specialized agencies of the UN;
 - (v) private foundations such as the Carnegie Corporation, Rockefeller Foundation, the Wellcome Trust, the MacArthur Foundation, the Edna McConnell Clark Foundation, the Sasakawa Memorial Health Foundation, the Aga Khan Foundation, the Pew Charitable Trusts and the Ford Foundation;
 - (vi) nongovernmental organizations whose work relates to health research in various ways, including, for example, the International Planned Parenthood Federation, the Program for Applied Technology in Health, and the Council on Health Research for Development;
 - (vii) pharmaceutical and other companies, which are modest investors in health research and major investors in product development.

How do all these organizations at both levels talk to each other? Currently, most do so only through occasion-

al or intermittent links that owe as much to informal networking as to a structured intent to share information. In health research there are only limited formalized review activities, most having either a particular focus or non-permanent resources. WHO's Advisory Committee on Health Research advises the WHO Director-General and the Organization on current trends and issues in science, particularly as they bear on the research activities of WHO itself. The Council on Health Research for Development facilitates individual countries' assessments of their national needs for health research and aims to increase the representation of low-income countries in setting international health research priorities. In addition, there have been periodic, intermittent reviews of health R&D needs, such as the present review and its forerunners. But there is no continuing, informed effort to provide analysis and to facilitate coordination for investors and researchers at international level. We shall return to this issue later.

Figure 7.1 sets out the existing system in schematic form, showing the health service providers, R&D institutions, R&D networks and investors that we have listed above. As the figure emphasizes, there are important flows of resources, information and products between these groups but relatively little analytic overview or monitoring of these flows.

With this descriptive background in mind, we now turn to a discussion of the potential solutions to some important current problems in the system for international health research. Since these problems are familiar to most of those who are involved in the field, the Report will not rehearse them in detail but will summarize them. It focuses first on the operational level, with discussion of the issues of capacity-building in low-income countries and a discussion of possible mechanisms to enhance cooperation between public and private sectors. It then moves on to the resource allocation level of R&D, to address the wider issues of funding, needs assessment and prioritization.

7.2 Building capacity for R&D

7.2.1 The problem: too few good scientists

A lack of resources has long handicapped R&D into the health problems of poor populations. Comparative data on human capital for different regions are difficult to obtain and are subject to bias and the effects of highly incomplete data. However, estimates from UNESCO suggest that about four-fifths of working scientists of *all disciplines, including health*, are concentrated in the Western industrialized nations, Japan and, to a much lesser extent, other large Asian countries. Africa, Latin America and the Middle East *together* have only some 13% of the world's scientists (UNESCO 1996). While Japan has one scientist for every 250 people, most low-in-

Table 7.1 R&D scientists (all disciplines) and engineers by region, 1992

Region/country	R&D scientists and engineers (thousands)	Population (millions)	R&D scientists per 1000 population
European Union	682.0	369.0	1.8
European Free Trade Association	32.6	11.9	2.7
Central and Eastern European countries	285.5	131.0	2.2
Israel	20.1	5.4	3.8
Commonwealth of Independent States	452.8	283.0	2.2
United States	683.7	257.5	2.7
Canada	64.6	27.8	2.3
Latin America	158.5	464.6	0.3
North Africa	81.6	219.7	0.4
Middle and Near East	117.4	465.9	0.3
Sub-Saharan Africa	176.8	482.6	0.4*
Japan	497.3	124.8	4.0
Newly industrialized Asian countries	136.7	92.5	1.5
China	391.1	1 205.0	0.3
India	106.0	887.7	0.1
Other Asian countries	60.3	513.5	0.1
Australia–New Zealand	48.5	21.2	2.3
World total	3 995.5	5 563.0	0.7

*Includes South Africa.

Note: the categorization of economic regions used in this analysis does not correspond with the system adopted elsewhere in this Report but general comparisons can be drawn.

Source: Observatoire des science et techniques (Paris) data in UNESCO 1996

come countries make do with one for several thousand people (see Table 7.1). The existing disparity is exacerbated by the brain drain, whose beneficiaries are principally the established market economies, but also the richer middle-income countries within each region. South Africa, for example, has obtained a substantial human resource from other southern African states.

While no one would argue that scientists from low-income countries should be denied rights to work where they have opportunities—rights long enjoyed by scientists from high-income countries—the globalization of labour markets for the highly skilled presents the low-income countries with serious policy challenges about how to prioritize scarce funds and, indeed, whether sufficient resources can be committed to create the environment for excellence and to retain and use capable scientists.

The conduct of research and development in low-income and middle-income countries is commonly hampered by this brain drain to the richer nations. For those who remain, there are considerable problems at the operational level. We summarize them here.

Just as the quality and productivity of research effort varies dramatically from one institution to another within the established market economies, it varies in the low-income and middle-income countries. Exemplary work is done in a number of institutions and countries; but in general, the obstacles to high quality are greater when countries' incomes are lower. Inadequate training, insufficient staff motivation and lack of competition prevent many institutions from attaining their potential. Lack of leadership, the instability of short-term funding, isolation from peers and poor access to the research literature all compound the problem and prevent researchers from responding rapidly to ever-changing demands. Salaries

are generally very poor; rewards to productivity are hampered by non-merit considerations in the appointment and promotion of senior staff and by restrictive personnel policies. Core support for the maintenance of libraries, databases, equipment and buildings is inadequate; and communication between scientists at the regional and international level is difficult. Recent communications improvements resulting from electronic mail and distance learning programmes have tended so far to benefit those who are already internationally networked, not those who are most isolated.

The basic cell of research is a laboratory or unit headed by a senior scientist, with each research institute or university employing a number of senior scientists. A department or institute's interests will tend to be multidisciplinary, while each basic cell will focus on one discipline or a small set of closely related ones. Crucial to the success of research is the ability to respond quickly to change—both at the level of the individual cell and the institute as a whole. The basic cell must respond by acquiring new technologies and skills; the institute must respond by acquiring new or more developed disciplines. In the public sector at least, this ability to respond is continually compromised by the very nature of the mechanisms that fund R&D. Governments usually provide basic core funding for R&D institutes and their civil service personnel policies tend to push research institutions too heavily towards management structures that lack accountability, thereby creating institutions that become unproductive and unable to respond to new challenges. Over time, core budgets tend to be eaten up by salaries, reducing manoeuvrability still further. In order to overcome these structural weaknesses in institutions, network centres of the type described above have evolved in some countries.

Yet in many countries, even the scientists and institutions who overcome these structural barriers to productivity face another hurdle: the international invisibility of their work. Because of typical publication in English and, arguably, a mainstream “core” of prestigious publications whose interest is restricted largely to North America, Europe, Australasia and Japan, researchers from less favoured regions often find it difficult to share their findings with wider audiences. Estimates vary but one assessment of the papers for *all disciplines* published in 1994 in 3 300 journals included in the database of the Institute for Scientific Information, the Science Citation Index, found that 31% of all papers came from the United States, 8% each from Japan and the United Kingdom, and the vast majority of the remainder from the other established market economies and the former socialist economies. Among the low-income countries, only India and China produced more than 1% of the world total, and most produced much less than 0.1% (Gibbs 1995). The Science Citation Index, which accepts only journals that produce English-language abstracts and fulfil various other conditions, heavily underestimates the numbers of papers published in large middle-income countries such as Argentina, Brazil, Chile, and low-income countries such as China.

It is also possible to assess the more specific areas of biomedical and clinical research (though not other health research disciplines) using bibliometric methods. The regional patterns for biomedical and clinical research are shown in Table 7.2. Once again, they emphasize an orientation toward English-speaking and northern industrialized regions.

Of course, bibliometric analyses are of only limited value even when they are representative of all regions. One of their drawbacks is that they cannot measure the quality of work, but only the volume and the impact, as measured by the number of citations received. Another important drawback is their failure to capture the importance of turning R&D results into products and interventions, from drugs, vaccines and equipment to clinical algorithms, packages of services and essential drugs lists. Future assessment of international R&D activity should be augmented to incorporate indicators of the degree to which findings are put to use by health service providers.

The data and discussion above have demonstrated the unevenness of human resources and visible output in R&D between regions, emphasizing the relatively impoverished resources of the low-income and middle-income regions. Given that scientists operate in an international market, it might be argued that the relative share of the total pool of scientists and the visible productivity in any particular region is irrelevant to the conduct of good research worldwide, provided equal attention is paid to all region-specific health problems. Yet, however true this might be for certain other domains of science, the practice of health research relies heavily on close contact with other areas of the health sector, on the local epidemiological environment, and on clinical, behavioural and social sciences that are tied to national frameworks as well as global ones. Many of the needed solutions to the health problems of people in low-income countries are more likely to be found by researchers working closely with those populations than by researchers who remain remote from them. In addition, the development of research capacity depends on good training and teaching, and the establishment of an (often expensive) critical mass. These are more likely to be achieved by strong leaders within local structures and by concentrating resources on productive institutions while freeing the resources committed to nonproductive ones.

7.2.2 Proposed solutions

The Committee is convinced that health R&D effort and capacity in low-income and middle-income countries must be significantly increased and strengthened if the emerging challenges to global health are to be tackled effectively. We summarize here some of the conditions that, in our view, would facilitate productive R&D efforts and competitive research capacity creation. We then suggest some practical proposals for realizing these conditions, proposals that rely, for the most part, on *national* policies and commitments. Our emphasis is on developing mechanisms to focus resources on productive institutions. Since resources are limited, these proposals will inevitably lead to geographical unevenness in the distribution of effort within each developing region.

Table 7.2 Percentage share of published papers in health R&D accessible on international databases, 1993

Country/region	Clinical medicine	Biomedical research
Europe	41.0	36.8
Commonwealth of Independent States	1.4	2.9
North America	41.3	44.9
Latin America	1.3	1.3
Middle Eastern crescent	0.9	0.4
Sub-Saharan Africa	1.2	0.5
Industrial Asia	8.1	9.5
Other Asian countries	1.6	1.4
Australia–New Zealand	3.2	2.3
TOTAL	100.0	100.0

Note: data on other health research disciplines not available.

Source: Observatoire des science et techniques (Paris) data in UNESCO 1996

Individual teams, institutions and programmes have demonstrated that it is possible to do first-rate research in low-income and middle-income countries. Their experience and advice have been well documented elsewhere (see, for example, the interviews with individual leading researchers in TDR 1995). Certain factors apparently help to ensure the success of institutions and programmes, and the Committee highlights them here. They include:

- autonomous management;
- appropriate compensation policies that will attract young and talented scientists;
- the capacity to train a large number of individuals from whom subsequent leaders can emerge. The number must be large enough to allow for transfer to other sectors and other losses;
- stable core funding;
- a significant element of competitive funding which might be allocated to research projects, or to individual development, or to institutional development;
- internationalization, and collaboration not only with institutions in the North but also with other institutions in the South;
- increased use of electronic media for peer review and publication as a first step towards reducing the regional bias in established publishing formats.

Investors and institutions could take a number of steps to make these factors more widespread. More institutions in low-income and middle-income countries should be freed from civil service management procedures, as is happening already in other government-funded institutions worldwide. This step would enable institutions to offer salary scales that will give them a competitive advantage and begin to combat the brain drain. To secure good staff, institutions should be enabled to recruit by active search and on the basis of peer-reviewed competition. Some—and possibly many—national governments will conclude that the financial, administrative and even political costs of these steps exceed their benefits. This may be a reasonable choice, but it creates an environment where science is unlikely to flourish and where competition for support is unlikely to be effective.

In the Committee's view, institutions are more likely to succeed if they receive stable core funding, but also if a proportion of their work is funded competitively. They may decide to support some extramural work, set up collaborative networks with an element of competition, or develop internal competition mechanisms. Some institutions, such as the Oswaldo Cruz Foundation in Brazil, have already moved in these directions with great success, for example by freeing up intramural resources for competitive allocation between groups and within the institution, with assessments being made by an external review group. There have also been notable successes with the formation of networks such as the International Clinical Epidemiology Network (see Box 7.1).

High-quality research increasingly depends on inter-

national collaboration, and almost no institution can now perform effectively without an international element. Institutions should therefore expect that some of their staff will be foreign nationals, although restrictive policies in some countries may, at present, prevent this. Where foreigners may not be employed, it is at least preferable for the scientific advisory board of the institution to contain some international representation. Staff should be enabled to participate in international fellowship schemes, exchanges and other mechanisms that foster long-term links and enhance the capacity of reciprocating institutions.

7.3 Accessing the power of the private sector

The contribution of the private sector to health research, in the traditional pharmaceuticals (drugs, vaccines, diagnostics, devices) industries and in a growing list of other health products such as health education materials, has been highly significant in recent decades. Public sector requirements for new product development are dependent on industry for many reasons, including the industry's expertise in development, its efficiency as a manufacturer and distributor, its knowledge and skills in market research and, not least, its financial power. Officials in a number of countries are exploring the ethics and potential of new collaborative ventures between the private and public sectors (Yach 1995), and their efforts may bring significant new funding sources to address unmet health needs. For the present, however, both private and public sectors recognize that the health problems of the world's poorest are neglected by industry. The problem is most acute in relation to pharmaceutical products, and we shall focus on them here.

7.3.1 The problem: too few incentives to invest

The poor lack buying power in the world's markets and there are thus few or no incentives for industry to engage its expertise with their problems. The costs of bringing a new pharmaceutical product from laboratory bench to market have been estimated at as high as US\$ 359 million and the process may take 10 years or more. These costs must be recovered through pricing the resulting product at levels far above the (often quite small) marginal cost of production and packaging. The short-term monopoly over a product that the near-global patent system confers—through the power of government—allows these high prices and the consequent underuse of the product in its first few years on the market. As a result of this system, there is little incentive for investing in markets where the possibility of recovering costs is perceived to be poor. The industry is also deterred by the perceived greater risk of investing in products for low-income markets, and a number of

Box 7.1 Capacity-building: the INCLEN experience

The International Clinical Epidemiology Network (INCLEN) began life in the early 1980s. Started by the Rockefeller Foundation, its aims are to strengthen research in health institutions, to improve medical education and training, and to encourage evidence-based clinical practice around the world. It seeks to do so by building up a critical mass of researchers to form clinical epidemiology units, each staffed by epidemiologists, health economists, social scientists and biostatisticians. There are now 35 such units in 18 countries: each one conducts health services research to support rational decision-making by service providers and provides research consultation and teaching.

During the first 10 years of the programme, INCLEN has trained more than 300 people in six centres in Australia, Canada and the United States. During the last three years, the training programme's emphasis has moved to the middle-income and low-income regions, and training centres have been established or are under development in Brazil, Chile, China, Colombia, India, Indonesia, the Philippines and Thailand.

INCLEN graduates have published more than 500 articles in peer-reviewed journals. Equally important, the network's research has already influenced health policy in several countries. For example, research on the effectiveness and efficiency of immunization against hepatitis B virus in the Philippines resulted in the addition of hepatitis B vaccine to the country's immunization programme.

And research on the cost-effectiveness of short-course chemotherapy for tuberculosis led to a change in the national treatment policies of Brazil, the Philippines and Thailand.

INCLEN strengthens local capacity by providing support for initial training and encourages continuing education through start-up research grants, annual scientific meetings, peer teaching and site visits by staff from the training centres. INCLEN participants have also formed regional networks for regular meetings and collaboration. The network also provides a small amount of core support for computers, teaching materials, communications and administrative staff.

The network's success is due to two key factors: first, INCLEN has a long-term vision and has been working with its participating institutions for more than a decade, recognizing that capacity-building can take time. Second, it has adopted a strategy of changing the health system by changing the perspective of its stakeholders. INCLEN targets academic physicians in major teaching centres who have established their careers and hold positions of influence within the medical system. Deans of medical schools, for example, are involved to ensure institutional support, including the protection of members' time for research and training. The network has maximized the opportunities for sharing experience, resources and skills—and its work is starting to bear fruit.

companies have withdrawn products from these markets after experiencing extremely low sales. Although many products can be brought to the market for much less than the sums that are widely quoted, there are clearly strong disincentives for investment in markets where purchasing power is perceived to be extremely limited.

This may be illustrated by several recent cases of vaccines developed for the prevention of diseases prevalent in low-income countries. Several highly promising candidate vaccines against diseases of major importance, such as diarrhoea caused by rotavirus, have reached an advanced stage of development. However, the lack of suitable funding to proceed to essential clinical trials and the lack of incentive for industry have proved to be serious hurdles in the final stages.

It is possible that some markets in the middle-income countries will grow extensively in coming decades and that this will encourage the pharmaceutical companies to invest in them. However, this prospect seems unlikely for the poorest regions, particularly sub-Saharan Africa, whose health needs are currently greatest and projected to remain so for the foreseeable future, and where pharmaceutical production is currently low (see Table 7.3). Market growth is also likely to be concentrated in the

middle and upper classes whose health needs more closely resemble those of the high-income countries than of the poor in their own countries. Only to the extent that their governments act as purchasing agents for the poor—facilitated by overall national economic growth—can purchasing power become significant; we shall return to this point.

As a result of these constraints on the private sector, national and international research programmes in the public sector, and with support from the private foundations, have increasingly accepted that they must take some responsibility for researching and developing products themselves, through new mechanisms of collaboration with industry. At the same time, the pharmaceutical industry is itself adapting to recession and other factors to turn itself more into an integrated organizational framework that is comparable to some of the international R&D programmes financed by the public sector. This is partly because of the growing interdependence of different types of skill and capacity in the industry, as, for example, in the relationships between the small biotechnology companies and the larger, more stably resourced, pharmaceutical companies. The industry increasingly contracts out its research and manufacturing components, locating each component in the most

Table 7.3 Production and consumption of pharmaceutical preparations, 1990 (in billions of 1980 U.S. dollars)

	Production	Consumption	Imports as % of consumption ^a
Developed market economies	109.7	107.8	8.2
North America	34.1	34.6	2.7
Western Europe	40.4	36.5	20.3
Japan	33.5	34.6	2.1
Others	1.7	2.1	30.5
Former socialist economies	12.9	14.0	NA
Developing countries	27.7	28.4	19.8
Latin America and Caribbean	11.9	9.0	10.6
North Africa	0.6	1.4	58.5
Other Africa	0.6	1.5	61.2
South and South-East Asia	7.4	8.4	15.1
China	5.3	5.4	3.7
Others	1.9	2.7	48.2
Total	150.3	150.3	—

^aThese figures are for 1989 and include intraregional trade.

Source: Ballance, Pogany & Forstner 1992: tables 2.1, 2.3, 2.10

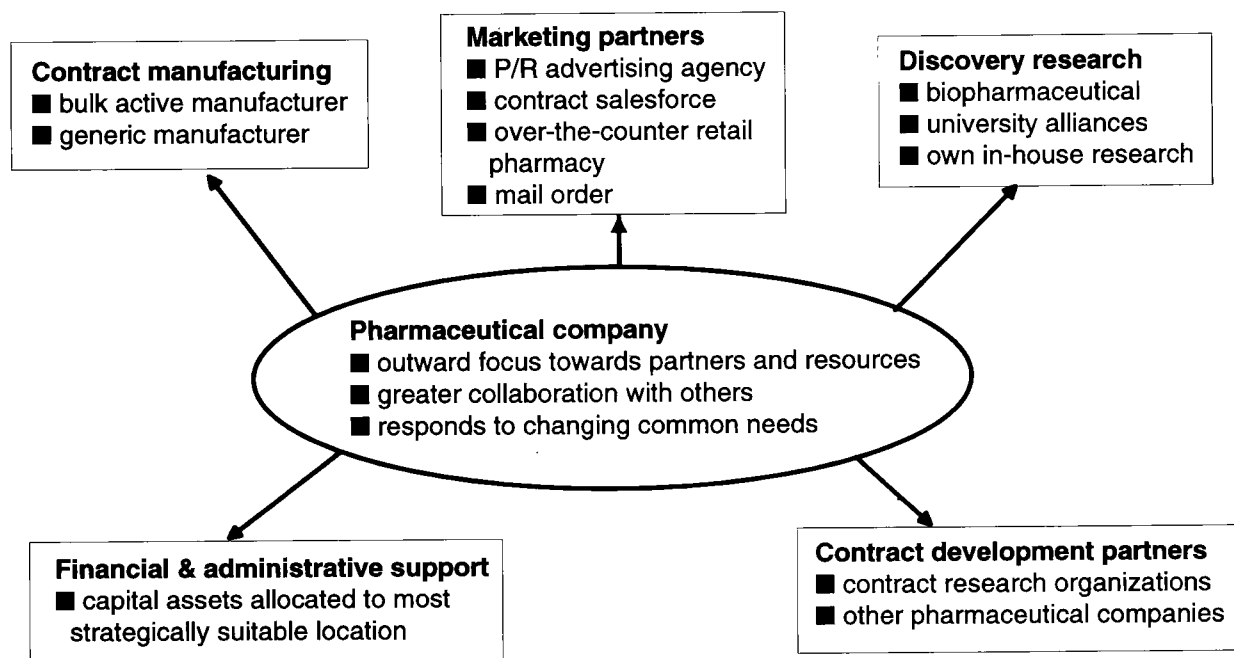
economically and technically suitable location rather like an assembly industry. The increasing integration has been described as a move towards an “extended family” network (see Figure 7.2).

7.3.2 Proposed solutions

The failure of current incentive structures to produce health products for the lowest income groups demands remedial action, and this Committee can merely add its voice to several more specialized reviews of need and opportunity in this area. In essence, the public sector must either harness the skills, energy and capacity of the private sector to develop *and bring promptly to market* products for the lowest income groups, or it must take responsibility for doing so itself. In reality, a combination of the two is likely. After some consultations between representatives of both sectors, the Committee has concluded that a number of actions may be taken to enhance cooperation between them, based on existing experience where successes have been achieved. The public sector may engage the private sector in each of the following ways:

- by supporting the costs of the early stages of product development, from compound screening right through to phase II trials if necessary, and offering to support post-marketing surveillance;
- by providing the industry with detailed analyses of the potential market and of the risks and benefits of introducing a product;
- by providing the industry with guaranteed markets for new products such as vaccines. In such schemes, national governments agree to purchase a known quantity of a specified product, raising the financing either from their national budget or through special loans. The up-front investments needed for successful collaborations of this type must be large;

- by streamlining the regulatory controls imposed by the public sector on the industry to the minimum necessary for good standards, in order to cut the industry's costs;
- by carefully designed tax relief schemes;
- by financial incentives within the patents system. A number of attempts to modify the patent system have been attempted, such as the Orphan Drug Act of 1983 in the United States. This gives companies tax breaks and lengthened exclusivity rights for drugs with small markets, creating strong incentives where there are third-party reimbursement mechanisms that are relatively insensitive to cost. However, the act has not reversed the downward trend in R&D on drugs for diseases that are prevalent in demographically developing countries and further extension of the period of patent protection—beyond the 20 years recently internationally agreed in the Uruguay round—is unlikely to substantially affect incentives, pointing to the need for additional mechanisms;
- by making the best use of the extraordinary commitment of individuals and particular companies within the private sector. Some have already demonstrated themselves willing to undertake research and development, production and supply of drugs on a break-even or defined-profit basis; more may be encouraged to do so. The example of some individuals is clear. For example, Jonas Salk, when asked who owned the patent on his polio vaccine, answered: “Well, the people, I guess. There is no patent. Could you patent the sun?” Salk believed that public goods should be common property for all time. The Committee certainly feels that there is a major role for patents among the instruments of government policy designed to stimulate innovation. Yet the spirit that Salk conveys—of personal or corporate commitment—represents an important additional resource to draw upon. Likewise innovation at public expense, even if in the private sector, requires an important reduction in

Figure 7.2 The virtually integrated pharmaceutical group model

Source: Scrip 1994

unrestricted patent rights, as, for example, through guaranteeing relatively low prices to public-sector buyers.

As a practical step towards putting some of these mechanisms in place, the Committee proposes a specific new initiative: a Health Product Development Facility or Alliance. The proposed facility or alliance would aim to enable private–public sector collaboration to develop cost-effective products for important health problems of people with very low incomes. Its work should be tightly focused on a limited number of products for major causes of disease burden that are currently neglected by existing efforts—such as many of those needed to address the R&D agenda identified in response to the threat from continually changing microbes. The facility or alliance should have a clear strategy to enable, and in some cases directly manage, the speedy development and deployment of those products; a professional management team with expertise from the pharmaceutical industry; adequate financial and human resources; and regular scientific review. It should facilitate, where appropriate, collaborations between large multinational pharmaceutical companies and small emerging companies in middle-income and low-income countries. Its expertise should include staff with skills and experience in the international regulatory systems. While public sector support will be essential, the facility's roles should include

catalysing new and non-traditional funding sources and it should make full use of any resources made available to it by the pharmaceutical industry, such as laboratory facilities or staff.

7.4 Investment in health R&D: trends, prospects and proposed solutions

This section discusses global health research at the level of resource allocation, beginning with an overview of overall investment trends, and moving on to discuss the gaps in research needed to meet the challenges identified in earlier chapters.

7.4.1 Problem 1: health investments are not being directed at global health challenges

R&D has a low claim on the health expenditure of all but a few nations. As a share of the world's total expenditure on health, research claimed just 3.4% in 1992 (see Figure 7.3). No government, whether in developed or developing regions, accords research more than about 5% of its total domestic health spending, and for most the share is much lower. In 1992, the United States spent

5.1% of its total publicly funded health expenditure on R&D, Denmark spent 3.8% and Germany 3.3%. Most countries spent less than 2% (Annex 5). Available data from middle-income countries suggest that R&D is seen as an equally low priority. For example, South Africa spends no more than 1.7% of its total health budget on R&D, while for Mexico the figure is no more than 0.5%.

The health problems of low-income countries are the first casualties of this relative neglect of R&D. Even though 90% of disease burden is in low-income and middle-income countries, only about 5% of R&D funds are spent on health problems that are overwhelmingly found in poor populations. Defining those health problems is a complex task, but several different definitions yield broadly similar figures (Annex 5). If, for example, we take a traditional definition of these health problems that is limited to parasitic diseases, the childhood infections and maternal and perinatal conditions, then about US\$ 2.4 billion or 4.3% of the total global R&D investment can be said to be spent on these problems. This definition, while clearly providing an incomplete picture of low-income and middle-income countries' health needs at the end of the 20th century, does reflect the current priorities within the system for international health R&D. We find that of this US\$ 2.4 billion, approximately half comes from the governments of middle-income and low-income countries. Of the remainder, about US\$ 683 million came from the governments of the established market economies, US\$ 400 million from the pharmaceuticals industry, and about US\$ 80 million from private foundations.

As earlier chapters have shown, analysis of spending by specific health topics also shows a neglect of the problems that currently dominate low-income and middle-income countries. For example, pneumonia, diarrhoeal disease and tuberculosis, which together made up more than 18% of *global* disease burden in 1990, collectively receive no more than US\$ 133 million in R&D funds each year—or 0.2% of the US\$ 56 billion spent on health research worldwide (Annex 5). This is equivalent to just US\$ 0.51 per DALY for pneumonia, US\$ 0.32 per DALY for diarrhoeal disease, and US\$ 0.68 per DALY for tuberculosis. By contrast, asthma—which is currently, if

not permanently, a health problem mainly of the industrialized countries—received more than US\$ 13 in R&D funds for each DALY.

Funding for R&D on the emerging problems of poorer populations also appears to be neglected, though assessments are inherently more complex for these problems because the distinctions between regions are becoming increasingly blurred. There is massive investment in cardiovascular disease, neuroscience, and oncology in the established market economies, but much of this is directed at the development of therapies that are not likely to be cost-effective in the resource-poor nations whose need for them is increasing most rapidly. The Committee has attempted to assess investment on a few of these health problems. R&D on the health impact of tobacco was found to receive no more than US\$ 164 million per year, equivalent to less than US\$ 4.50 per DALY. If, however, that level of investment does not rise in real terms as the smoking epidemic takes its toll, by 2020 only about US\$ 1.25 will be spent on R&D for each DALY arising from this massive health problem. And studies of the health impact of road-traffic accidents, at least that research funded by the public sector rather than by the motor industry, show an even greater neglect. Current investment is estimated to be no more than US\$ 34 million a year, equivalent to US\$ 0.83 per DALY. By 2020, without real increase, the projected burden expected from road-traffic accidents would mean that just US\$ 0.40 was spent for each DALY.

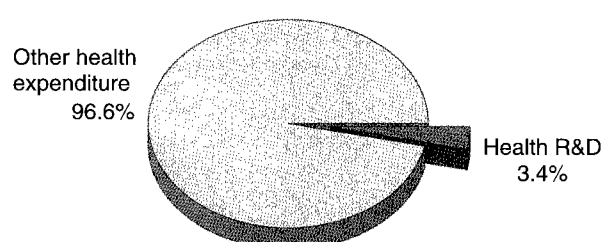
Although there are many factors to consider when judging priorities for R&D, there is little doubt that better information on the balance between investment and disease burden would prove a highly provocative aid to decision-makers. Our own analyses are clearly only a very partial beginning; more systematic assessments will be needed to provide a fuller picture.

7.4.2 Problem 2: investment in the health needs of poorer populations is falling

Through the late 1980s, investment in health R&D rose sharply in real terms worldwide, from US\$ 38 billion in 1986 to US\$ 56 billion in 1992, measured in constant 1992 dollars. But the rate of growth has now declined in both the public and private sectors (Annex 5). The pharmaceutical industry, which during the 1980s expanded its investment in R&D more rapidly than the public sector in the United States, has recently sharply contracted its investment because of the soaring costs of health care, which have led the industry to project a decrease in its profit margins. Because of the projected decrease, the rate of growth in R&D investment in the pharmaceutical industry has tumbled from an average of 12.7% in real dollars in the early 1980s to 5.6% by the beginning of the current decade. There is some evidence that this contraction has disproportionately affected work on antimicrobials—a shift that is likely to affect low-income populations most acutely.

However, it is the sharp decline in investment in offi-

Figure 7.3 Per cent of global health spending on health R&D, 1992



Source: Annex 5

cial development assistance (ODA)—also called development cooperation assistance—from the governments of the established market economies to the rest of the world that is most likely to impact upon health research for poorer populations. On average, the governments of the rich nations are now allocating just 0.36% of their GDP to their ODA budgets, half the target set by the OECD. The share of this total allocated to health has declined too, and within the health budget less than one-tenth is allocated to R&D.

Official development assistance is given in two ways—as bilateral assistance directly from one government to another; or as multilateral assistance, from a government to an international agency which acts as an intermediary and passes it on to a recipient country. About 44% of ODA for health R&D is given as bilateral funds, the rest as multilateral funds. Bilateral funding for health R&D as a part of all ODA has declined sharply in real terms since 1992. The decline has been sharpest in the United States, Canada and Sweden, which between them in 1992 provided about four-fifths of the total bilateral ODA for health R&D. The United States Agency for International Development, which had rapidly increased its funding for health R&D in the late 1980s, cut its commitment by 30% between 1992 and 1994 and further reductions are expected. Overall, bilateral commitments to the health sector dropped 37% between 1988 and 1993.

Trends in multilateral funds for health R&D are more difficult to assess because of the accounting systems of the donors and recipients of these funds. The principal agencies that receive multilateral funds are the UN organizations, but multinational, nongovernmental organizations such as the Council on Health Research for Development (COHRED) and the International Health Policy Programme (IHPP) also receive some multilateral support. As well as providing regular, budgetary support to international organizations, many governments choose to provide additional discretionary (or extrabudgetary) funds to specific research programmes. These extrabudgetary funds are classified as multilateral aid and it is possible to get a partial picture of multilateral investment trends by examining extrabudgetary contributions to particular research programmes.

Two such programmes, the Special Programme of Research, Development and Research Training in Human Reproduction (HRP) and the Special Programme for Research and Training in Tropical Diseases (TDR), have been regarded as excellent investments by many donors and have been frequently cited as models for the effective support of R&D. Box 7.2 summarizes some of the key achievements of these programmes and shows the cumulative investments of a number of countries, including relatively small nations such as Denmark, Norway and Sweden, that have been critical in bringing these high returns for global health. Yet even for these two special programmes, the trends are disturbing. Investment has begun to show some downward trends, with the contributions of many donors declining in the early 1990s (Annex 5).

As the discussion in this section has shown, finance for R&D is not reaching the health problems that need it most—those that are responsible for the greatest disease burden worldwide. The sharp downward trend in official development assistance and the slowing growth in overall R&D investment are both likely to exacerbate already gross imbalances between the needs of the majority and the efforts of the scientific community. In the Committee's view, these imbalances, and the downward trends in investment, point to two failures of the international health system: first, a failure to monitor broad trends and allocate resources in a rational manner; and second, a failure to convince those at the highest political levels of the enormous human and economic payoff from R&D that, we believe, demonstrably justifies greater investment. The fragmented nature of health R&D may have contributed to this second failure, by preventing the development of strong and coherent international advocacy. In our view, the major challenges that governments face in the next 25 years in dealing with health problems will not be met without serious efforts to overcome these failures.

7.4.3 Proposed solutions

In the Committee's view, there is a need for a mechanism to enable the review of global health needs, the assessment of R&D opportunities and the monitoring of resource flows. There is also a need for advocacy for health research to convince governments and other investors, including non-traditional sources, of its benefits in improving health and enhancing economic development among the poorest populations. The Committee considers that such a mechanism could be created out of existing health research structures. A new collaboration, which might be called the Forum for Investors in International Health R&D, could bring governments, other investors and scientists together to perform these functions. Such a forum would base its reviews on analytic data on the health needs of countries and regions. Its aims would be to identify existing effort and fill important gaps in global health research, particularly those that affect poor populations, and to help reduce overlap and waste. To perform its function effectively, it would need access to high-quality analytic capacity to supply it with data on disease burden, reasons for the persistence of that burden, measurements of the cost-effectiveness of potential interventions, current patterns of spending on R&D, and assessments of national health system performance.

Such a forum would take advice from existing scientific advisory groups already involved in enabling health research at national and international levels, such as the WHO's Advisory Committee on Health Research system, scientific and advisory groups of existing international research programmes, and bodies such as the Council on Health Research for Development (see Box 7.3), the International Clinical Epidemiology Network and the International Health Policy Programme. Its rec-

ommendations and conclusions would be presented to existing programmes for consideration and implementation.

The proposed forum should have certain key characteristics. It should be inclusive, with all partners having an equal footing. It should be informal, should respect the mandates of its partners and should strengthen rather than diminish each partner. It should not be a legal entity nor the creature of any specific organization; its conclusions should be made widely available to all who might be interested in them to inform decision-making by others (see Figure 7.4).

One important function of the forum would be to demonstrate at national and international levels the benefits of health research, and, through the data on resource flows and performance that it could generate and monitor, to convince investors—including, perhaps, new and non-traditional sources—of the high payoffs that research can bring. Another critical function would be to establish (and update) a *short* list of key R&D products to be realized in a specified time frame, to monitor progress on

items on the list, and to remove items from the list as they reached completion or if progress faltered excessively. If WHO were to take the lead in the establishment of such a forum with the help of other key players, the advantages would be many, including a speedy aggregation of dispersed international R&D activities.

In order to strengthen resources for research on the major challenges to global health, the Committee concludes that additional specific initiatives are needed in four areas. Three of these have been identified already in the Recommendations sections of Chapters 4, 5 and 6 and the need for the fourth initiative has been discussed in greater detail in section 7.3 above. *All of these initiatives can be achieved through the consolidation and enhancement of existing institutions and structures.* To summarize, the initiatives are:

- A Special Programme for Research and Training on Noncommunicable Diseases and Healthy Aging;
- A Special Programme or Initiative for Research, Training and Capacity-Building on Injuries;

Box 7.2 High returns: the outcomes of investment in two R&D programmes

The parasitic diseases and poor reproductive health that plague so many people in low-income countries are now under sustained attack from two highly effective programmes, the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR) and the Special Programme of Research, Development and Research Training in Human Reproduction (HRP).

Some key achievements of TDR include:

- success in treating leprosy using multidrug therapy in combinations tested and monitored by the programme. Leprosy is due for elimination as a public health problem by the end of the decade;
- the control of onchocerciasis (river blindness) now promises to be sustainable. Success has been achieved through treatment with the drug ivermectin combined with rapid epidemiological mapping, monitoring and distribution methods;
- the expected interruption of the transmission of Chagas disease by the end of the decade in the southern cone of Latin America as a result of control using fumigant cans, insecticidal paint and techniques to screen donated blood in blood banks;
- the development, through multicentre trials, of effective control programmes for lymphatic filariasis based on the use of diethylcarbamazine, ivermectin and soap and water.

Some key achievements of HRP include:

- the development of new or improved methods for regulating fertility, including: new monthly injectables, extension of the duration of effectiveness of copper IUDs to 11 years and confirmation of their safety in women at low risk for STDs, the evaluation of the potential of antiprogestins for fertility regulation, and ongoing clinical trials of antifertility vaccines and hormonal methods for males;
- the assessment of the long-term safety of existing methods of family planning including reassurance on the relationship between oral contraceptives and cancer, and updated information on the relationships between oral contraceptives and cardiovascular disease;
- the assessment of the behavioural determinants of choice of family planning methods, including understanding of the reasons why women resort to unsafe abortions, as a means to inform intervention development.

Both programmes have contributed strongly to strengthening research capability in low-income and middle-income countries. Through TDR support, for example, 17 institutions in disease-endemic countries have now reached an international standard and regularly compete with laboratories in non-endemic countries.

The countries and international organizations that have supported this work over two decades have been repeatedly persuaded of the value of their investment in improving human health. In many cases, small countries have played key roles (see Box Table 7.2.1).

(Box 7.2 continued)

Box Table 7.2.1 Cumulative voluntary contributions to two international research programmes, 1970–95 (millions of U.S. dollars)

UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR), 1974–95		Special Programme of Research, Development and Research Training in Human Reproduction (HRP), 1970–95	
Source	Amount	Source	Amount
Denmark	53.1	Sweden	92.1
World Bank	48.3	UK	60.2
USA	46.0	UNFPA	48.0
Sweden	45.8	Norway	43.4
Norway	46.6	Denmark	29.5
UNDP	42.3	World Bank	19.3
The Netherlands	23.5	Germany	13.1
WHO	23.4	WHO (regular budget)	12.8
Germany	21.6	USA	11.2
Canada	21.4	Canada	10.0
UK	19.2	The Netherlands	5.1
Switzerland	18.3	Australia	3.5
Belgium	10.4	Rockefeller Foundation	3.2
Australia	8.7	Finland	2.8
Italy	6.3	Switzerland	2.7
MacArthur Foundation	6.1		
Japan Shipbuilding Industry Foundation	5.9		
France	5.8		
IRDC	3.3		
Finland	2.8		
African Development Bank Group	2.3		
Others	12.9	Others	40.6
Total contributions to each programme*	474.0		398.0

*Only contributions greater than US\$ 2 million are itemized.

- A Special Programme for Research and Training on Health Systems and Policy; and
- A Health Product Development Facility or Alliance.

It is not for the Committee to specify exactly how such initiatives might best be organized. The essential requirement is to enhance and expand effort in these areas without delay by whatever means should be considered most effective.

7.5 Chapter summary and recommendations

The current system for the conduct and financing of international health research is unable to respond adequately to the world's current and changing health needs. In particular, a lack of capacity at national and regional level is holding back high-quality research, while inadequate collaboration between private and public sectors is directly affecting the health of poorer populations. At the

resource allocation level, there is neglect for health R&D overall, a severe imbalance of resources away from the needs of low-income populations, and a lack of mechanisms to facilitate coordination between investors. The result is fragmentation, some duplication, some gaps and a dispersion of resources. At a time when research has more than ever to give, this suggests two failures of the international health research community: first, to allocate its effort in a rational manner to improving health; and second, to convince investors and potential investors of the benefits of investing in research for health.

The following recommendations are addressed to investors: some are more particularly the concern of governments in middle-income and low-income countries, and some the concern of governments in the established market economies and other traditional "donors" to health R&D. The recommendations outline some steps that might be taken to proceed, first in terms of the operation of research at national and international levels, and finally in terms of resources and international coordination.

Recommendations

1. Governments have much to gain from the development of national agendas for health research, with the active involvement of all relevant actors, including scientists, service providers, policy-makers and community leaders. Such agendas are likely to be most useful if their focus includes both population health needs and available R&D capacity. Investors may increase the efficiency of R&D by strengthening national and regional research capacity, through, for example, focusing efforts on areas of comparative advantage, on improvements in the quality of training, on explicit initiatives to translate results into relevant policies and interventions; by offering incentives to reverse the brain drain, by promoting policies that require research posts to be competitive and based on the peer-reviewed allocation of funds, and by making core support for institutions competitive. Additionally, supporting national institutions with a strong international orientation—in funding, staffing and mandate—might have a high payoff. The returns on investment in good standards are likely to be significant, while poor-quality or repetitive research is wasteful and may have adverse consequences for health.
2. Investors may profitably explore the development of new instruments—beyond the current patents system—for engaging the skills and energy of the private sector in the development of vaccines, antimicrobials and other drugs, diagnostic tests, devices and prostheses and equipment for the use of low-income populations. These incentives could include development subsidies, extended patent protection, guaranteed markets, streamlined regulatory requirements, improved market information (including certification of product quality) and contracting for specific tasks. The Health Product Development Facility or Alliance recommended by this Committee is a potentially effective mechanism to focus and synergise efforts—not only for products to combat the major microbial threats, but also for maternal and child health and for the coming epidemics of noncommunicable diseases and injury.
3. A Forum for Investors in International Health R&D should be formed to provide a mechanism for the review of needs and opportunities for global health R&D—making use of analytic data on disease burden, R&D opportunities and the level of ongoing efforts. The forum would bring together the governments of low-income and middle-income countries, the major traditional “donors”, and the research community. Analytic work undertaken by and for the forum would provide improved information for decentralized decisions on funding and resource allocation. This in turn should help to focus resources more sharply on completing the highest priority tasks before moving on to others.
4. Given the high returns to R&D in health improvement, a reallocation of health sector resources to

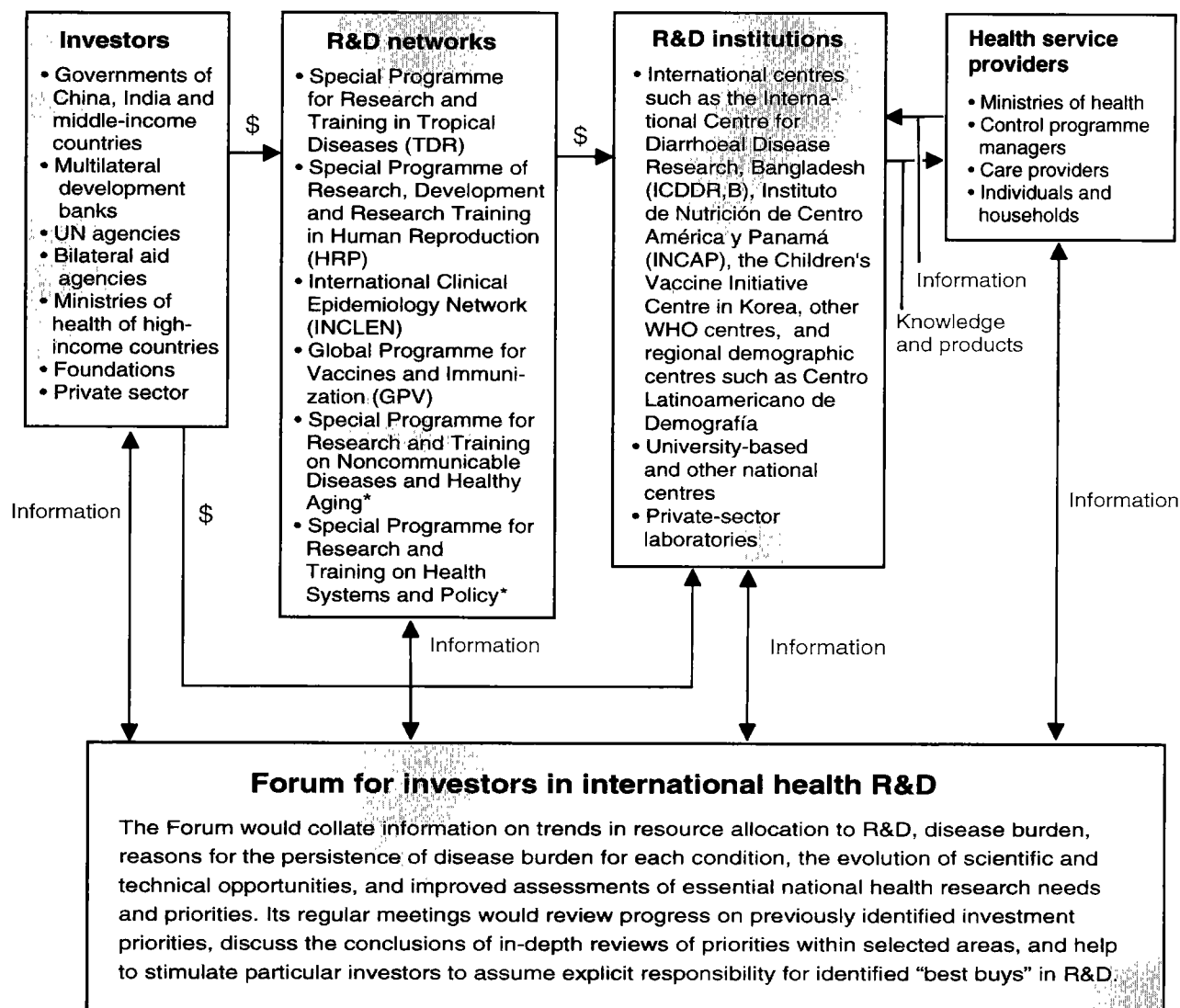
Box 7.3 The Council on Health Research for Development

The concept of Essential National Health Research grew out of the work of the Commission on Health Research for Development, whose purpose was to recommend how R&D could improve the health and well-being of the peoples of low-income and middle-income countries. The Commission argued that every country, no matter how poor, should have a health research base that will enable it to understand its own problems and enhance the impact of limited resources to improve health. Scientists, decision-makers and representatives of the people should all be involved as equal partners in the process of setting priorities for national health research and determining an agenda for action.

Towards this goal, the Council on Health Research for Development (COHRED) was set up following a resolution at the Second International Conference on Health Research for Development in March 1993. COHRED was to promote, facilitate, support and evaluate the Essential National Health Research strategy and other health issues of international priority. It took

over from the task force formed to implement the Commission's recommendations.

Today more than 40 countries are collaborating with COHRED in implementing a strategy. Research agendas cover a broad range of problems but reflect common key concerns, ranging from sanitation and water safety to the need for research to inform health policy at local and national levels. The Council enables countries, agencies and organizations, both governmental and nongovernmental, to work together to promote, facilitate and support Essential National Health Research and to address health issues of international priority that require joint action. It works with countries to build links between researchers, health care providers, decision-makers and community representatives at all levels of the health system. These links are crucial if research is to help inform intelligent decisions and result in relevant action. The Council also works closely with international research programmes, UN agencies and other international organizations pursuing health and equity.

Figure 7.4 The international health R&D system: proposed enhancement

*Proposed new programme

R&D is recommended as a means to bring substantial net gains in health, particularly the health of poor populations. Given that much of R&D provides an *international* public good, there is a particularly strong case for public sector investors in the established market economies to re-allocate their health portfolios to increase R&D funds. The institutional capacity for supporting health R&D that many traditional donors possess strengthens the case for them to increase this form of assistance. The globalization of health problems suggests that sources of investment in

international health R&D should be diversified in order to enhance the likelihood of finding appropriate solutions to them. The ministries of health and research councils of high-income countries have much to gain from participating. Governments of low-income and middle-income countries are likely to find increased allocations to appropriate health R&D to be both a cost-effective way of improving health in their populations and, potentially, an investment in the infrastructure for productive national industries.

Bibliographical notes and references

A series of background papers was commissioned in support of the Committee's work; the first section below lists these papers and their authors. Bibliographic notes for each chapter come next, followed by the references for the Report.

List of supplementary papers

1. Institutional development options for international health R&D—by Rajiv Misra and Joël Almeida. Fax: (91-11) 242-2664.*
2. Setting priorities for the development of vaccines for parasitic diseases—by David B. Evans and G. Azene. Fax: (41-22) 791-4854.
3. *Health policy and systems development: an agenda for research*—edited by Katja Janovsky. Fax: (41-22) 791-0746.

WHO Document WHO/SHS/NHP/96.1, Geneva, World Health Organization. This book contains a set of papers, most of which were prepared as background papers for the Ad Hoc Committee's review. The volume includes: Health policy and systems research: issues, methods, priorities by Katja Janovsky and Andrew Cassells (which appears as Annex 9 of this Report); Priority setting in health by Chris Ham; Priority setting and cost-effectiveness by José Luis Bobadilla; Health needs assessment by Martin McKee; Financing by Barbara McPake; The public/private mix in health care systems by Sara Bennett; The role of the private sector in health financing and provision by Peter Berman; Decentralization, two papers, by Thomas Bossert and Charles Collins; Quality of health services by James Heiby; Monitoring systems by Richard Cibulskis and John Izard; The policy process by Anne-Marie Foltz; and Policy analysis: an approach by Gill Walt.

4. Expenditures on health R&D in India—by Joël Almeida and Rajiv Misra. Fax: (41-22) 791-4199.
5. Health R&D funding: the case of Mexico—by Beatriz Zurita. Fax: (52-5) 655-8211.
6. Expenditures on health R&D in South Africa—by D. Yach. Fax: (41-22) 791-4161.
7. R&D priorities for controlling cardiovascular disease in low-income and middle-income countries—by T. Pearson, K. S. Reddy and P. Jha. Fax: (1-607) 547-3061.

8. Value for money in tuberculosis research: the global tuberculosis programme's investment matrix for R&D resource allocation—by Joël Almeida, P. Nunn and Arata Kochi. Fax: (41-22) 791-4199.

Bibliographic notes

Chapter 1

This chapter draws on published and unpublished sources. The discussion on previous efforts to identify criteria for priority-setting draws on Advisory Committee on Health Research 1986 and 1993; Advisory Committee on Medical Research 1976; Davies & Mansourian 1992; Commission on Health Research for Development 1990; World Bank 1993; and unpublished materials from the Council on Health Research for Development supplied by personal communication.

The discussion on scope and definitions draws on World Health Organization 1978; Webster 1975; Davies & Mansourian 1992; and CIOMS 1993. The discussion on intervention cost-effectiveness draws on Jamison 1993; and Mark et al. 1995.

Box 1.2 draws on Annex 1 of this Report and the companion volumes to this Report (Murray & Lopez 1996 and forthcoming). Ongoing discussion concerning formulations of the DALY measure is reviewed in Morrow & Bryant 1995. Jamison, Jamison & Shibuya (forthcoming), in work undertaken for this Committee, provide an alternative formulation of the DALY that explicitly adds in loss from late fetal death and that reduces the relative burden of death in very early childhood relative to that in later life.

In addition the chapter draws on Boldú & de la Fuente 1993; Bush 1945; Fourth World Conference on Women 1995; National Research Council & World Bank 1995; UNICEF 1994; United Nations Development Programme 1993; World Bank 1990; and World Health Organization 1995.

Chapter 2

This chapter draws on Advisory Committee on Health Research 1994; Anderson & Williams 1995; Bankowski & Bryant 1995; Committee on Criteria for Federal Support of Research and Development 1995; Dahlman 1995; Evans, Barer & Marmor 1994; Fleischmann et al. 1995; Jamison 1993; McKeown 1988; Murray, Lopez & Jamison 1994; Mushkin 1979; *The economist* 1995; Patrick & Erickson 1993; Schultz 1993 (especially Part III, "Augmenting resources by organized research", pp. 149–198); Taskforce on Research Innovations for Productivity and Sustainability 1995; TDR 1995; U.S. Congress, Office of Technology Assessment 1990; Vernon 1989; Weisbrod

* Fax numbers given are for the first listed author of each paper.

1983; World Health Organization 1992; World Bank 1993; and World Bank 1995. The discussion on past health trends draws on Preston & Haines 1991; Ewbank & Preston 1990; and McKeown 1976. The section on current determinants of health draws on Caldwell & Caldwell 1985 and 1993; Caldwell 1993; Davey-Smith & Egger 1992; Department of Health and Social Security (United Kingdom) 1980. The note of the effects of antimicrobials on the Allied troops is drawn from Bush 1945. Discussion of the economic benefits of health research draws on National Institutes of Health 1995 and on unpublished data of the National Institutes of Health presented in discussion meetings (February 1995) and supplied to members of the Committee by personal communication. The discussion of the role of telemedicine is based on information from Basshur 1995. The note on the impact of evidence-based medicine draws on material provided by the UK Cochrane Centre. The quotation from Robert Oppenheimer is from Rhodes 1986.

Chapter 3

This chapter draws on published and unpublished sources and benefited from comments from a number of technical experts. The introductory discussion on packages and the assessments of their cost-effectiveness draw on Bobadilla et al. 1994; and World Bank 1993. The section on pneumonia draws on Stansfield & Shepard 1993; and CDR 1995a. The section on malaria draws on TDR 1995; Olliaro, Cattani & Wirth 1996; and the estimates of cost-effectiveness of bednets and vaccines draw on a supplementary paper to this Report by David Evans and G. Azene (Supplementary paper 2); D'Alessandro et al. 1995; and Picard et al. 1993. Data on vaccine coverage in the section on immunization were provided by the EPI Information System. The immunization section also draws on Lee 1995; Begg & Cutts 1994; Institute of Medicine 1985; Katz & Gellin 1994; Leslie & Jamison 1990; and Mitchell, Philipose & Sanford 1993. The sections on nutrition draw mainly on Pinstrup-Andersen et al. 1993; Mason et al. (forthcoming); Pelletier 1994; and materials from the United Nations Administrative Committee on Coordination, Subcommittee on Nutrition (ACC/SCN). The section on intestinal helminths draws on World Bank 1993 and a number of other published and unpublished sources including Awasthi et al. 1995. The section on reproductive health draws on Walsh et al. 1993; World Bank 1993; *Population reports* 1992; and Khanna, Van Look & Griffin 1994. Discussion of contraception research draws on unpublished discussion papers from the UNDP/UNFPA/WHO/World Bank Special Programme of Research, Development and Research Training in Human Reproduction (HRP); and Khanna, Van Look & Griffin 1994. Discussion of the Mother-Baby package draws on MSM 1994; and World Health Organization 1995. The note to Table 3.7 refers to a background paper proposed by Jamison, Jamison and Shibuya (forthcoming).

Chapter 4

The chapter draws on material from unpublished and published sources and consultations with a number of technical experts. The introductory section draws on Institute of Medicine 1992; Centers for Disease Control and Prevention 1994; Berkelman et al. 1994; CDR 1995a; Garrett 1995; Institute of Medicine 1985; Lederberg, Shope & Oaks 1992; Galazka, Robertson & Oblapenko 1995. The discussion on tuberculosis draws on Global TB Programme 1995; Sudre, Ten Dam & Kochi 1992; Almeida, Nunn & Kochi, Supplementary paper 8. The discussion on pneumococcus draws on Schwartz et al. 1996; Klugman 1990; Koornhof, Wasas & Klugman 1992; and CDR 1995a and 1995b. The discussion on malaria draws on TDR 1995; Institute of Medicine 1991; Olliaro, Cattani & Wirth 1996; and Evans & Azene, Supplementary paper 2. The discussion on HIV and other STDs draws on World Bank 1993; Mann, Tarantola & Netter 1992; Khanna, Van Look & Griffin 1994; Cohen 1994; Gallo 1995; Nowak 1995; Murray & Lopez 1996 and forthcoming; Chin & Lwanga 1991; Cowley 1993; Grosskurth et al. 1995; and Division of Family Health 1995. The section on additional microbial threats draws on Bennish et al. 1992; and Rowe 1996. Additional sources include: Committee on International Science, Engineering and Technology 1995; Philipson & Posner 1993; Robbins & Bloom 1995; Rockefeller Foundation 1994; and Vermund, Schultz & Johnston 1994. Heise 1995 provides a valuable summary of the current status of development of vaginal microbicides—seven to ten products are now ready for human testing—and of reasons for its relative neglect within current patterns of funding for R&D relevant to the control of HIV transmission.

Chapter 5

A range of unpublished and published sources helped to inform this chapter, together with the advice and comments of several technical experts. The discussion of health transition in an aging population draws on Jamison & Mosley 1991; Bobadilla et al. 1993; and Jamison et al. 1993. The discussion of psychiatric and neurological conditions draws on Cowley & Wyatt 1993; Üstün & Sartorius 1995; and personal communication with Norman Sartorius and others. The sections on tobacco draw on Stanley 1993; Peto et al. 1994; Peto et al. 1995; Liu et al. 1995; and personal communication with Richard Peto and Alan Lopez. The section on cancers draws on Barnum & Greenberg 1993; Bratthall & Barmes 1993; and World Health Organization 1995. The section on respiratory diseases draws on Bumgarner & Speizer 1993; and on personal communication with technical experts. The section on cardiovascular diseases and diabetes draws on Pearson, Jamison & Trejo-Gutierrez 1993; Pearson et al. 1994; Hutt 1991; Feachem, Jamison & Bos 1991; Vaughan, Gilson & Mills 1993; Barker et al. 1993; Anti-Platelet Trialists' Collaboration 1994; and on personal communication with K. S. Reddy (All India Insti-

tute of Medical Sciences) and others. Data from the WHO Sino-Monica study informed the discussion on obesity. Additional information in the section on non-communicable diseases draws on Javitt 1993; Pope & Rall 1995; and Veil 1992. The section on aging as a development issue draws on HEE 1995; U.S. Bureau of the Census 1992; Ebrahim & Kalache 1996; and Kalache & Aboderin 1995. The data on Brazil are from a World Bank report (Brazil Department 1988 and 1989). The section on injuries draws on a paper prepared by the University of South Africa Health Psychology Unit, 1996; Stansfield, Smith & McGreevey 1993; and Butchart 1995.

Chapter 6

The discussion on health and the economy draws on Fundación Mexicana para la Salud 1996; World Bank 1993; Weil et al. 1990. The discussion of intersectoral activities benefits from information and material provided by Drs Derek Yach (including at the Heath Clark Lecture 1995) and Tord Kjellström; and from Mansourian & Sayers 1995. The discussion on health systems and health care expenditure draws on material from the OECD and the advice of Drs Jean-Pierre Poullier, David Evans and Julio Frenk; Afifi, Berkanovic & Zhang 1995; Alderman 1994; Carballo 1994; Cassels 1995; *Lancet* 1992; Committee on Health Services Research 1995; Committee on Methods for Setting Priorities for Guidelines Development 1995; Frenk 1987; Frenk et al. 1994; Frenk 1994; Gunatilleke 1995; International Health Policy Programme 1995; Murray, Govindaraj & Musgrove 1994; National Health Service R&D Task Force 1994; Pan American Health Organization 1995; Task Force on Health Economics 1995; UK Cochrane Centre 1995; UK Department of Health 1995; van Doorslaer, Wagstaff & Rutten 1993; White et al. 1992; HEE 1995; World Bank 1993; World Bank 1994a; and World Bank 1994b. The discussion on research priorities on populations and households draws on Annex 8 of this Report and that for research priorities on health policy and health systems draws on Annex 9, together with the supplementary papers on health systems research commissioned for this Report and listed in the first part of this section. Important insights into how to better catalyse the utilization of R&D findings by policy-makers may be found in the literature on diffusion of innovations. See, for example, Valente & Rogers 1995.

Chapter 7

This chapter draws on published and unpublished sources and its content benefited from a series of discussion meetings and reviews. The section on capacity-building draws on Coleman 1993; Commission on Health Research for Development 1990; Gibbs 1995; Godal 1994; Goodstein 1993; *Harvard business review* 1994; International Vaccine Institute nd; TDR 1995; and UNESCO

1996; together with advice from a number of individuals and particularly from the Supplementary papers and materials produced for this Committee by Joël Almeida, Rajiv Misra and Beatriz Zurita and listed in the first part of this section. The discussion on the private sector draws on Ada 1994; Altman 1995; Bloom 1994; Comanor 1986; Institute of Medicine 1987; Kinnon 1995; Mastroianni, Donaldson & Kane 1990a and 1990b; Misra 1995; Nogués 1993; Reich et al. 1995; Rosenberg, Gelijns & Dawkins 1995; Scherer 1993; *SCRIP* 1994; U.S. Congress, Congressional Budget Office 1994; U.S. Congress, Office of Technology Assessment 1993; Weisbrod 1989; and information provided by Beatriz Zurita. Discussion of the ethics of using nontraditional sources of income to fund medical and health research draws on Yach 1995. The section on investment in health R&D and on investment trends draws primarily on Annex 5 and additional information provided by Catherine Michaud. The chapter also draws on annexes 3, 4, 6 and 7. In the context of discussing the need for an HIV vaccine and current barriers to private sector development efforts, Rowely and Berkley 1994 summarize conclusions from a Bellagio conference that are of general relevance to consideration of how to enhance private sector involvement in new product development. An important example of effective collaboration between industry and government at an international level is the ongoing series of negotiations directed at achieving much greater harmonization of standards among drug and medical equipment regulatory agencies around the world. Nightingale 1994 summarizes the status of these efforts. Success in these negotiations will lead to reductions in product development costs as well as more rapid diffusion of new drugs and devices. The discussion of competitive mechanisms to strengthen R&D mechanics draws on Cowling, Sigmon & Putman 1996.

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Appendix A

World Health Organization Ad Hoc Committee on Health Research Relating to Future Intervention Options— Participants in the Review

Committee members

Professor Dean T. Jamison
(COMMITTEE CHAIR)
Professor of Public Health, and
Director, Center for Pacific Rim Studies
University of California, Los Angeles
Los Angeles, CA 90095-1487
USA
tel: (1-310) 206-0223
fax: (1-310) 206-4018

Ph.D. in economics, Harvard University; M.S., engineering, Stanford University. Professor Jamison served as an economist on the staff of the World Bank for most of the period 1976–93. During 1992–93, he led the World Bank team that authored *World development report 1993: investing in health*, and he was the lead editor for the companion volume, *Disease control priorities in developing countries*, published by Oxford University Press. His professional interests include the use of economic analysis to inform public-sector policy in health and education. He was elected to the Institute of Medicine, U.S. National Academy of Sciences, in 1994.

Professor Kamini Mendis
(COMMITTEE CO-CHAIR)
Department of Parasitology
Faculty of Medicine
University of Sri Lanka
P.O. Box 271, Kynsey Road
Colombo 8, Sri Lanka
tel: (94-1) 69-9284
fax: (94-1) 69-9284

M.D., University of Colombo; Ph.D. in parasite immunology, University of London. Professor Mendis is an authority on malarial transmission, pathogenesis and drug resistance. She was Pasteur-Weissman Scholar at the Institut Pasteur in Paris in 1991. Among the awards she has received are the Presidential Award for Science (Sri Lanka, 1983) and the Ademola Medal (University of London, 1993).

Professor Adenike O. Abiose
Medical Director
National Eye Centre
National Institute of Ophthalmology
PMB 2267
Off Express By-Pass
Kaduna, Nigeria
tel: (234-62) 23-39-56
fax: (234-62) 21-56-42

FRCSed in ophthalmology, Royal College of Surgeons, Edinburgh; FWACS in ophthalmology, West African College of Surgeons. Professor Abiose is a specialist in causes and prevention of eye diseases. She was Professor and Chair of the Department of Ophthalmology at Ahmadu Bello University from 1982 to 1991. She is currently a member of the Expert Advisory Committee of the Onchocerciasis Control Programme in West Africa and the Scientific and Technical Advisory Committee of the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases.

Dr A. Asamoah-Baah
Director
Policy, Planning, Monitoring and Evaluation
Division
Ministry of Health
P.O. Box M44
Accra, Ghana
tel: (233-21) 66-54-21 ext. 4208
fax: (233-21) 66-38-10

MBBS, Ghana Medical School; M.A. in community health, Liverpool School of Tropical Medicine, UK. Dr Asamoah-Baah has worked with the WHO Division of Strengthening of Health Services on a number of projects, including restructuring the headquarters of the Ministry of Health, Ghana, and reviewing financial management, policy, strategy and human resources development in Ghana. He is a specialist in planning and evaluating health services. Dr Asamoah-Baah is a former Deputy Regional Director in charge of disease control of the Ghanaian Ministry of Health, Ashanti Region, 1988. He was also District Medical Officer of Health, Offinso District, and Health Coordinator, Catholic Diocese of Kumasi, Christian Health Association of Ghana, 1986-87. He is a member of the Scientific and Technical Advisory Committee of the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases.

Dr Sune Bergström
Karolinska Institute
Nobelkansliet
Box 270
S-171 77 Stockholm, Sweden
tel: (46-8) 611-8587
fax: (46-8) 611-1733

Dr Seth Berkley
Associate Director
Division of Health Sciences
The Rockefeller Foundation
420 Fifth Avenue
New York, NY 10018
USA
tel: (1-212) 852-8324
fax: (1-212) 764-3468

Professor Barry Bloom
Investigator, Howard Hughes Medical
Institute, and
Weinstock Professor of Microbiology and
Immunology
Albert Einstein College of Medicine
Forchheimer Bldg, Room 411
1300 Morris Park Avenue
New York, NY 10461
USA
tel: (1-718) 430-2221 or 2889
fax: (1-718) 904-1473

Professor David Bradley
Professor of Tropical Hygiene
London School of Hygiene and Tropical
Medicine
Keppel Street
London WC1E 7HT, UK
tel: (44-171) 927-2216
fax: (44-171) 580-9075

Professor Gelia T. Castillo
Professor of Rural Sociology
Department of Agricultural Education and
Rural Studies
College of Agriculture
University of the Philippines
Laguna, Philippines
tel: (63-2) 596-813
fax: (63-2) 521-1036 (c/o IRRI)

Professor Chunming Chen
Senior Advisor
Chinese Academy of Preventive Medicine
27 Nan Wei Road
Beijing 100050
China
tel: (86-10) 318-6655 ext. 2411
fax: (86-10) 317-0892

Dr Bergström is Emeritus Professor of medical chemistry at Karolinska Institute. Dr Bergström is a former Chairman of the Global Advisory Committee on Health Research and of the WHO Special Programme of Research, Development and Research Training in Human Reproduction (HRP), and is currently a member of the Council on Health Research for Development. He is at present concerned with safe motherhood.

M.D., Brown University. Dr Berkley is a specialist in the epidemiology of HIV/AIDS and sexually transmitted disease. He has done extensive research on the epidemiology of AIDS in Africa, and has managed the Rockefeller Foundation's programmes in epidemiology, public health, medical and nursing education, AIDS and STDs. He was part of the core writing team for the *World development report 1993: investing in health*.

Ph.D. in immunology, Rockefeller University. Professor Bloom is an expert in immunological response to diseases. He was Chairman of the Immunology of Leprosy and Immunology of Tuberculosis Committees at WHO and Chairman of the Scientific and Technical Advisory Committee to the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases. He is currently Co-chairman of the Board on International Health of the National Research Council. In 1991, he received the first Bristol Myers Squibb Award for Distinguished Research in Infectious Diseases. Professor Bloom is a member of the U.S. National Academy of Sciences and of its Institute of Medicine.

D.M., University of Oxford; FRCP, Royal College of Physicians of London. Professor Bradley's professional and research interests include tropical public health, health aspects of water, epidemiology and control of vector-borne diseases, genetics of resistance to infection, and environment, health and development. He has served as a consultant to the World Bank and WHO on environmental issues and their effects on health.

Ph.D., Cornell University. Professor Castillo has done extensive research on agricultural and rural development and social infrastructure in the Philippines. She is Vice-Chair of the Council on Health Research for Development and has served on more than 70 national and international boards, advisory committees, and review teams concerned with, among other things, tropical disease, health policy, and international development. In her work, she has sought to find a niche for the social sciences in R&D establishments, and—through her participation in research policy-making bodies worldwide—to present the perspective of developing country researchers.

B.S. in agricultural chemistry, National Central University, China. Professor Chen has been Dean of the Union School of Public Health at Beijing Union Medical University since 1989. She served as Director of the Department of Health and Epidemic Prevention for China's Ministry of Health, 1983-92. She is a specialist in nutritional science. Her research and professional interests include community nutrition, public health policy on nutrition, and the prevention of noncommunicable disease.

Professor Mercedes Concepcion
2423 Zamora Street
Pasay, Metro-Manila 1300
Philippines
tel: (63-2) 831-8452
fax: (63-2) 917-8616 (c/o UNFPA)

Ph.D. in sociology, University of Chicago. Dr Concepcion is Emeritus Professor of the College of Social Sciences and Philosophy of the University of the Philippines, Quezon City. Her professional interests cover the range from social science research and its applications in reproductive health, population policy, population and development, and demographic analysis, to women's studies. Professor Concepcion currently is a member of the Scientific and Technical Advisory Group, Human Reproduction Programme, WHO.

Professor Gertrude B. Elion
Scientist Emeritus
Glaxo Wellcome Co.
3030 Cornwallis Road
Research Triangle Park, NC 27709, USA
tel: (1-919) 315-4547
fax: (1-919) 315-8349

M.S. in chemistry, New York University. Professor Elion was awarded the Nobel Prize for physiology or medicine in 1988. Her research interests include chemistry and the biological activity of purines and pyrimidines, chemical immunosuppression, and chemotherapy of cancer, viruses and protozoal diseases. She is a member of the National Academy of Sciences, the Institute of Medicine and the American Academy of Arts and Sciences.

Dr Richard G.A. Feachem
Senior Population, Health and Nutrition
Adviser
The World Bank
Room S-1045
1818 H Street, N.W.
Washington, DC 20433
USA
tel: (1-202) 473-0632
fax: (1-202) 522-3234

Ph.D. in environmental health, University of New South Wales; D.Sc. in medicine, University of London. Dr Feachem was the Dean of the London School of Hygiene and Tropical Medicine from 1989 to 1995. His professional and research interests include epidemiology, health policy, childhood infections, and environmental health. He is Fellow of the Faculty of Public Health Medicine of the Royal College of Physicians.

Dr Julio Frenk
(CO-CHAIR, WORKING GROUP II)
Executive Vice-President of the Mexican
Health Foundation, and Director of the
Center for Health and the Economy
Fundación Mexicana para la Salud
Periférico Sur 4809
14610 México D.F.
Mexico
tel: (52-5) 655-9011
fax: (52-5) 655-8211

M.D., National University of Mexico; Ph.D. in medical care organization and sociology, and M.P.H., University of Michigan. From 1984 to 1987, Dr Frenk was the founding Director of the Center for Public Health Research, and from 1987 to 1992 he was founding Director-General of the National Institute of Public Health of Mexico, where he maintains an academic appointment. He is concurrently Adjunct Professor in the Faculty of Medicine of the National University of Mexico. His areas of interest include medical manpower, health transition, and policy implications of shifts in the dominant patterns of health and disease.

Baron Dr Paul Janssen
Chairman
Janssen Research Foundation
Turnhoutseweg 30
B-2340 Beerse, Belgium
tel: (32-14) 602-111
fax: (32-14) 603-942

M.D., State University of Ghent, Belgium. Dr Janssen, a prominent figure in the pharmaceutical industry, was elevated to the Belgian baronage in 1990. He is the founder and was Chairman of Janssen Pharmaceuticals. Dr Janssen has been awarded over 20 honorary doctorates and professorships from institutions in 13 different countries, and is the author of more than 800 scientific publications.

Dr Maureen Law
Director-General
Health Sciences Division
International Development Research Centre
P.O. Box 8500
Ottawa, Ontario K1G 3H9, Canada
tel: (1-613) 236-6163
fax: (1-613) 567-7748

M.D., Queen's University, Canada. Dr Law has served as Chair of the Executive Board of WHO, Chair of the Global Commission on AIDS, and Canadian Deputy Minister of National Health and Welfare. Her leadership in public health-care administration earned her the Prime Minister's Award for Outstanding Achievement in Public Service (Canada, 1986) and the "Health for All" Medal (WHO, 1988).

Dr Philippe Lazar
 Director-General
 INSERM
 101, rue Tolbiac
 75656 Paris Cedex 13, France
 tel: (33-1) 44 2361 80
 fax: (33-1) 44 45 85 14 67

Dr Sverre O. Lie
 Chairman
 Department of Pediatrics
 Rikshospitalet
 N-0027 Oslo, Norway
 tel: (47-2) 286-9006, 9005
 fax: (47-2) 242-2822

Dr Juan Luis Londoño
 (CO-CHAIR, WORKING GROUP II)
 Lead Research Economist
 Office of the Chief Economist
 Inter-American Development Bank
 1300 New York Avenue NW
 Washington, DC 20577
 USA
 tel: (1-202) 623-3550
 fax: (1-202) 623-2481

Dr Mahmoud M. Mahfouz
 Professor of Radiation Oncology and
 Nuclear Medicine
 15b Sherif Street
 Cairo, Egypt
 tel: (20-2) 392-6670
 fax: (20-2) 392-3726

Dr Anthony B. Miller
 Department of Preventive Medicine and
 Biostatistics
 University of Toronto
 McMurrich Building
 12 Queens Park, Crescent West 4th Floor
 Toronto, Ontario M5S 1A8, Canada
 tel: (1-416) 978-2040
 fax: (1-416) 978-8299

Mr Rajiv L. Misra
 (CHAIR, WORKING GROUP III)
 C-73 Preet Vihar
 Delhi 110-092, India
 tel: (91-11) 221-9904
 fax: (91-11) 242-2664

Ecole Polytechnique, France. Dr Lazar's areas of research include applied statistics, epidemiology and chemical carcinogenesis. Since 1982 Dr Lazar has been Director-General of the French National Institute of Health and Medical Research (INSERM), and since 1994, Chair of the European Medical Research Council. Among his honors is the Légion d'Honneur (Officier), 1994.

M.D., Ph.D., University of Oslo. Dr Lie is a specialist in pediatrics and medical genetics. His research and professional interests include general pediatrics, international health, genetics and pediatric oncology. He was Professor and Chair of the Pediatric Research Institute of the University of Oslo from 1975 to 1989, and since 1989 has been Professor and Chair of the Department of Pediatrics, University of Oslo. He is President of the International Society of Pediatric Hematology and Oncology.

Ph.D. in economics, Harvard University. Dr Londoño was the Minister of Health of Colombia from 1992 to 1994. He is an economist with professional experience in the areas of health, education, poverty, social security, decentralization, and employment promotion. Dr Londoño's areas of interest include social policy, labour markets and macroeconomic issues in economic development. Prior to joining the Inter-American Development Bank he served as a principal health economist with the Technical Department for Latin America and The Caribbean, the World Bank.

M.B., C.H.B., Cairo University; FRCR in radiation oncology and nuclear medicine, University of London. Professor Mahfouz was the Minister of Health of Egypt, 1972–74. His research interests include radiation oncology and nuclear medicine. He received the Légion d'Honneur (Chevalier) of France (1978) and the State Merit Prize for Biological Sciences of Egypt (1990).

FRCP in medicine, Royal College of Medicine, London; FRCP(C) in medical science, Royal College of Physicians of Canada. Dr Miller was a member of the scientific staff for the Medical Research Council, Tuberculosis and Chest-Diseases Unit (London), and Director of the Epidemiology Unit of the National Cancer Institute of Canada. His professional and research interests lie in the epidemiology, treatment and screening of cancer. Dr Miller received the Eli-Lilly Canada Cancer Research Leadership Award in 1993, and the Distinguished Achievement Award of the American Society of Preventive Oncology in 1994.

M.A. in English literature, University of Lucknow, India. Mr Misra has served in several posts with the Government of India, including as Secretary of the Ministry of Health (1991–94), Secretary of the Ministry of Finance (1989–90), Secretary of the Ministry of Textiles (1988–89), and Chief Controller of Imports and Exports (1985–88). His professional interests are in public administration, economic management, development, and health research and policy.

Dr Carlos Morel
President
Oswaldo Cruz Foundation (FIOCRUZ)
Av. Brasil 4365, Manguinhos
Caixa Postal 926
Rio de Janeiro 21045-900, Brazil
tel: (55-21) 270-2496
fax: (55-21) 260-6707

Dr A. S. Muller
Professor of Tropical Health
Department of Social Medicine
Academic Medical Centre
Meibergdreef 15
1105 AZ Amsterdam, The Netherlands
tel: (31-20) 566-4602
fax: (31-20) 697-2316

Professor Christopher J.L. Murray
(CHAIR, WORKING GROUP I)
Harvard Center for Population and
Development Studies
Roger and Ellen Revelle Building
9 Bow Street
Cambridge, MA 02138
USA
tel: (1-617) 495-8498
fax: (1-617) 496-3227

Dr Plutarco Naranjo
Avenida 12 de Octubre 2206
Quito, Ecuador
tel: (59-32) 225-632
fax: (59-32) 568-114

Dr Sir Gustav J.V. Nossal
Director
Walter and Eliza Hall Institute of Medical
Research
The Post Office
Royal Melbourne Hospital
Melbourne, Victoria 3050, Australia
tel: (61-3) 345-2555
fax: (61-3) 345-2508

Dr B.O. Osuntokun (deceased)
Neurology Unit
Department of Medicine
University of Ibadan
P.M.B. 9388 Ibadan, Nigeria

M.D., Federal University of Pernambuco, Brazil; D.Sc. in natural sciences, Federal University of Rio de Janeiro, Brazil. Dr Morel's professional and research interests include molecular biology of parasites; Chagas disease and *Trypanosoma cruzi*; the development of diagnostic and molecular epidemiological tools based on new biotechnological approaches; and science and technology for health in developing countries. He is a senior member of the Brazilian Academy of Sciences.

M.D., Ph.D. in epidemiology, Leiden University. Dr Muller was Head of the Department of Epidemiology, Medical Research Centre, Nairobi (1971–77), and Director of the Department of Tropical Hygiene of the Royal Tropical Institute, Amsterdam (1978–90). His research interests lie in infectious disease epidemiology.

M.D., Harvard University; Ph.D. in health economics, Oxford University. Professor Murray's work has been concentrated in three areas: the epidemiology and control of tuberculosis, the quantification of the global burden of disease using disability-adjusted life-years (DALYs), and the improvement of allocative efficiency of health systems through cost-effectiveness analysis. He has served as Chair of the WHO Tuberculosis Operations Research Committee since its inception in 1992.

M.D., Central University of Ecuador, Quito. Dr Naranjo has been President of the Academy of Medicine of Ecuador (1982–86), and President of the Latin American Association of Academies of Medicine (1989–91). He is past Minister of Health of Ecuador (1988–92). He has written more than 300 papers and 25 books on science, medicine, history and literature.

MBBS; Ph.D., University of Melbourne. Dr Nossal is a specialist in immunology. His research interests include B-cells, T-cells, lymphokines, immunological tolerance, and isotype switching. He became Chairman of the Victorian Health Promotion Foundation in 1987 and Director of Sirotech Limited in 1991.

M.D.; Ph.D. in neurology, University of Ibadan. The late Professor Osuntokun was Provost and Medical Director of ARO Neuropsychiatric Hospital from 1983 to 1985. His research and professional interests included nutritional and toxic diseases of the nervous system, cerebrovascular diseases and related neurological diseases. Professor Osuntokun's distinguished career was brought to an untimely end by his death in September 1995.

Professor Richard Peto
Clinical Trial Service Unit and
Epidemiological Studies Unit
Radcliffe Infirmary
University of Oxford
Oxford OX2 6HE, UK
tel: (44-186) 557-241
fax: (44-186) 558-817

Dr Jean-Pierre Poullier
Head, Health Policy Studies
Organisation for Economic Co-operation
and Development (OECD)
2, rue Andre-Pascal
75775 Paris Cedex 16, France
tel: (33-14) 524-9186
fax: (33-14) 524-9098

Dr K. Srinath Reddy
Professor of Cardiology
Cardio-thoracic Centre
All India Institute of Medical Sciences
Ansari Nagar, New Delhi 110029, India
tel: (91-11) 685-2899
fax: (91-11) 686-2663

Dr Susanna Sans
Institute of Health Studies
U.D. Hospital Sant Pau
Pare Claret, 167
Barcelona 08025, Spain
tel: (34-3) 456-3612
fax: (34-3) 433-1572

Professor Norman Sartorius
1 chemin Gilbert Trolliet
1209 Geneva, Switzerland
tel: (41-22) 740-1538
fax: (41-22) 734-3469

Dr Jaime Sepúlveda
Director-General
Instituto Nacional de Salud Pública
Av. Universidad No 655 - 2o. Piso
Col. Sta. Ma. Ahuacatitlán
62508 Cuernavaca, Morelos, Mexico
tel: (52-73) 17-57-34
fax: (52-73) 11-24-72

Dr Vladimir P. Sergiev
Director
Martsinovsky Institute of Medical
Parasitology and Tropical Medicine
20, Malaya Pyrogovskaya
Moscow 119435, Russia
tel: (70-95) 246-8049 or 0644
fax: (70-95) 246-9047

M.Sc. in statistics, University of London; M.A., University of Cambridge. Professor Peto is ICRF Professor of Medical Statistics and Epidemiology, University of Oxford. Among the areas in which he has conducted research and published are mortality in relation to tobacco smoking, and methodology of randomized clinical trials. Among his awards is the Prix Raymond Bourguine for Achievement in Cancer Research (awarded jointly, 1995).

Ph.D. in economics, George Washington University, USA. Dr Poullier served as the Executive Secretary of the Experts Committee on the Competitive Capacity of the European Economy for the European Commission. He has been with the OECD since 1972. He is a member of the Board of the International Association of Income and Wealth and a member of the International Society of Technology Assessment in Health Care. He has lectured and published widely on public health.

M.D., D.M., All India Institute of Medical Sciences; M.Sc. in clinical epidemiology, McMaster University, Canada. Dr Reddy's professional and research interests are in cardiovascular epidemiology, preventive and clinical cardiology, and clinical epidemiology. He is a member of the National Academy of Medical Sciences (India) and the European Working Group on Cardiovascular Epidemiology. He was awarded the K.L. Chopra (Gold Medal) Award for Prevention Cardiology by the Indian Medical Association in 1994.

M.D., Ph.D. in epidemiology, Autonomous University of Barcelona. Dr Sans was the Director of the Chronic Diseases Research and Epidemiological Monitoring Programme (Department of Health and Social Security, Generalitat of Catalonia). Her professional and research interests include epidemiology and prevention of cardiovascular diseases and other chronic diseases. She is a member of the New York Academy of Sciences and the European Society of Cardiology.

M.D., Ph.D. in clinical psychology, University of Zagreb. Dr Sartorius is concurrently Professor of psychiatry at the universities of Zagreb, Geneva, and Prague. His professional and research interests include the organization of mental health services, and public health aspects of psychiatry. Among his honors is the Rema Lapouse Medal, awarded for his contributions to public health aspects of psychiatry.

M.D., University of Mexico; Ph.D., Harvard University. Dr Sepúlveda was Undersecretary of the Ministry of Health of Mexico (1991-94), and Chair of the Mexican National Vaccination Council (1990-94) and the National AIDS Council (1986-94). His professional and research interests include health surveys, epidemiological surveillance systems, and stochastic modelling. He is a member of the Mexican National Academy of Sciences and the Mexican National Academy of Medicine.

M.D., Ph.D., First Moscow Medical Institute. Dr Sergiev, who formerly served in many posts with the USSR Ministry of Health, now sits on several WHO committees and panels. He has published 185 papers in the field of epidemiology and control of malaria, AIDS, leishmaniasis, helminth infections, typhoid, cholera, assessment of disease burden and evaluation of disease prevention.

Dr Yukio Sugino
Adviser
Takeda Chemical Industries, Ltd.
3-6 Doshomachi 2-chome Chuo-ku
Osaka, Japan
tel: (81-6) 204-2027
fax: (81-6) 204-2168

Ph.D. in biochemistry, Nagoya University. Dr Sugino was the director of the Biotechnology Laboratory, and a Professor of biochemistry at the Institute for Virus Research, Kyoto University. His areas of research include nucleic acid biochemistry, biotechnology and molecular biology (virology and cell biology). He has been awarded the Young Scientist Prize of the Japanese Biochemical Society.

Dr Derek Yach
Chief, Policy Advisory Coordinating Team
Division of Development of Policy,
Programme and Evaluation
World Health Organization
CH-1211 Geneva 27, Switzerland
tel: (41-22) 791-2736
fax: (41-22) 791-4161

MBChB, University of Cape Town; M.P.H., Johns Hopkins University. Dr Yach was formerly the Director of the Center for Epidemiological Research in South Africa, and the Group Executive for Essential Community Health Research of the Medical Research Council of South Africa. His professional and research interests include the broad aspects of epidemiological research on TB, tobacco use, violence, measles, and interventions to promote health (legislative/fiscal/health education).

WHO Secretariat

Dr Tore Godal
(STUDY CO-DIRECTOR)
Director, Special Programme for Research
and Training in Tropical Diseases (TDR)
World Health Organization
CH-1211 Geneva 27, Switzerland
tel: (41-22) 791-3802
fax: (41-22) 791-4854

M.D., Ph.D., University of Oslo. Dr Godal is a specialist in immunology, infectious diseases and cancer. He has more than 300 publications in peer-reviewed journals on these topics. From 1974 to 1986 Dr Godal was Head of the Laboratory for Immunology at Norsk Hydro's Institute for Cancer Research at the Norwegian Radium Hospital in Oslo. Since 1986 he has been Director of UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR).

Dr James Tulloch
(STUDY CO-DIRECTOR)
Director, Division of Child Health and
Development (CHD)
World Health Organization
CH-1211 Geneva 27, Switzerland
tel: (41-22) 791-2111
fax: (41-22) 791-4853

M.B.B.S., Adelaide University, Australia. Dr Tulloch served as a consultant for the WHO Smallpox Eradication programme, 1976–79, and as a consultant and staff member of the WHO Diarrhoeal Diseases Control programme (CDD), 1980 and 1984–89. He was Director of the WHO Division of Diarrhoeal and Acute Respiratory Disease Control (CDR), 1990–96. His research and professional interests lie in child health and infectious disease control.

Dr David B. Evans
Economist
Special Programme for Research and
Training in Tropical Diseases (TDR)
World Health Organization
20, Avenue Appia
CH-1211 Geneva 27, Switzerland
tel: (41-22) 791-3767
fax: (41-22) 791-4854

Ph.D. in economics, Australian National University. Dr Evans is a specialist in health economics. Before joining WHO in 1990, he was a Research Fellow at the Development Studies Centre of the Australian National University from 1980 to 1984, a lecturer in the Department of Economics at the National University of Singapore, 1984–86, and a Senior Lecturer in health economics at the Centre for Clinical Epidemiology and Biostatistics at Newcastle University, Australia.

Dr Katja Janovsky
Social Scientist
National Health Systems and Policies
World Health Organization
20, Avenue Appia
CH-1211 Geneva 27, Switzerland
tel: (41-22) 791-2568
fax: (41-22) 791-0746

Dr Alan D. Lopez
Director
Programme on Substance Abuse
World Health Organization
20, Avenue Appia
CH-1211 Geneva 27, Switzerland
tel: (41-22) 791-2374
fax: (41-22) 791-4851

Dr Thomas C. Nchinda
(COMMITTEE SECRETARY)
Coordinator, Research Capability
Strengthening
Special Programme for Research and
Training in Tropical Diseases (TDR)
World Health Organization
CH-1211 Geneva 27, Switzerland
tel: (41-22) 791-3808
fax: (41-22) 791-4854

Ph.D. in administration, planning and social policy, Harvard University. Dr Janovsky has spent her career as an international health-care planner. She has served as a consultant on the development of health-planning strategies for various organizations including the World Bank and the Swedish International Development Agency. Since 1988 Dr Janovsky has been a member of the District Health System Group in the Division of Strengthening of Health Services at WHO headquarters.

Ph.D. in medical demography and epidemiology, Australian National University. Dr Lopez is the Director of the WHO Programme on Substance Abuse. His research interests include the epidemiology of tobacco use, especially chronic disease effects; global and regional cause-of-death estimates and projections; prevention of alcohol, tobacco and other drug use; and the risk assessment for alcohol use.

MBBS, University of Ibadan, M.D., D.T.P.H., University of London. Dr Nchinda was field doctor, later becoming Deputy Director and Director of Medical Services for West Cameroon (1967–72); Deputy Director in the Ministry of Health (1972); and Lecturer, Senior Lecturer and Head of the Department of Epidemiology and Community Health in the Medical School of the University of Yaounde in Cameroon (1975–83), before joining WHO. His professional and research interests are in tropical disease research and control, in the training and utilization of health personnel and in capacity building and health services research.

Committee staff

Dr Joël Almeida
(Research Associate)
c/o Global Tuberculosis Programme
World Health Organization
CH-1211 Geneva 27, Switzerland
tel: (41-22) 791-2655
fax: (41-22) 791-4199

Ms Phyllida Brown
(Science Writer)
28 Archbishops Place
London SW2 2AJ, UK
tel: (44-181) 674-5140
fax: (44-181) 244-8260

Mr Leslie Evans
(Production Editor)
Center for Pacific Rim Studies
11290 Bunche Hall
University of California, Los Angeles
Los Angeles, CA 90095-1487
USA
tel: (1-310) 206-3556
fax: (1-310) 206-4018

M.E.P. in general management, Indian Institute of Management; M.B.B.S., Christian Medical College and Hospital, Vellore, India; Ph.D. in epidemiology and quantitative modelling, London School of Hygiene and Tropical Medicine. Dr Almeida's research and professional interests include the management of change and innovation, consensus development, and health in development.

B.A. in human sciences, University of Oxford. Ms Brown has been a senior reporter and a biomedicine consultant to *New scientist* magazine. She has written on HIV/AIDS, malaria, health and development and other health-related issues. In 1990 she was awarded the Glaxo/ABSW Science Writers' Award in the category of "Improving Health in the 1990s".

M.A. in sociology, University of California, Los Angeles. Staff Research Associate and Publications Director, UCLA Center for Pacific Rim Studies. Production Editor, *Chinese science*. Editor, Monad Press, New York, 1967-79. UCLA Chancellor's Fellow, 1983-87. Author/editor of several books on Chinese and American politics.

Mr Richard Gunde
(Copy Editor)
Center for Chinese Studies
11353 Bunche Hall
University of California, Los Angeles
Los Angeles, CA 90095-1487
USA
tel: (1-310) 825-8683

M.A. in political science, University of California, Los Angeles. Assistant Director, UCLA Center for Chinese Studies. Associate Editor, *Modern China: an international quarterly of history and social science*. Managing Editor of the journal *Chinese science*.

Dr Catherine Michaud
(Senior Research Associate)
Harvard Center for Population and
Development Studies
Roger and Ellen Revelle Building
9 Bow Street
Cambridge, MA 02138
USA
tel: (1-617) 495-0419
fax: (1-617) 496-3227

M.D., University of Geneva; M.P.H. in international health, Harvard School of Public Health. Dr Michaud was Chief Resident for the Clinic of Pediatrics at the University of Geneva, and is currently a Senior Research Associate at the Center for Population and Development Studies, Harvard University. Her research interests include health expenditure, national burden of disease studies, and the efficacy of health interventions.

Mr Claude Nanjo
(Research Assistant)
Center for Pacific Rim Studies
11288 Bunche Hall
University of California, Los Angeles
Los Angeles, CA 90095-1487
USA
tel: (1-310) 206-8984
fax: (1-310) 206-4018

M.P.H., M.A. in African studies, University of California, Los Angeles. Mr Nanjo is currently studying the cost-effectiveness of various health interventions to be included in a package of essential health interventions.

Dr Norman Swan
(Communications Adviser)
ABC Radio
700 Harris Street, Ultimo
Sydney 200, Australia
tel: (61-2) 394-1407
fax: (61-2) 394-1414

MBChB, MRCP, DCH, University of Aberdeen and trained in pediatrics before going into medical journalism and broadcasting. He has his own weekly health programme on Australian national radio, produces television documentaries and publishes a health magazine for lay people. He has won the Australian equivalent of the Pulitzer prize for his reporting. He was General Manager of the Australian Broadcasting Corporation's Radio National, 1990-94, and is a member of AusAID's International Health Advisory Group.

Dr Beatriz Zurita
(Research Associate)
Fundación Mexicana para la salud
Periférico Sur No. 4809
Col. El Arenal Tepepan
Deleg. Tlalpan, 14610, México, D.F.
tel: (52-5) 655-9011
fax: (52-5) 655-8211

M.A. in applied economics, Ph.D. in epidemiological science, University of Michigan; M.D., University of Anahuac, Mexico. Dr Zurita was formerly the Department Head for Health Services Research of the National Institute for Public Health, Cuernavaca, Mexico. Her professional interests include the analysis of the quality and costs of health care, health-care financing and resource allocation, and health systems reform. In 1993 she was awarded a National Research Award from the Glaxo Foundation.

Harvard Burden of Disease Unit

Harvard Center for Population and Development Studies
9 Bow Street
Cambridge, MA 02138, USA
Tel: (1-617) 495-8498
Fax: (1-617) 496-3227

Dr Arnab K. Acharya
(Research Associate)

Ph.D. in macroeconomic theory and development economics, University of Illinois; M.P.H., Harvard University. Dr Acharya's current interest is health economics in developing countries and quantitative methods in health economics.

Mr Robert V. Ashley
(Research Assistant)

B.A., Harvard University. Has studied cost-effectiveness of health interventions and co-ordinated estimates of health research needs and the global burden of cancer.

Ms Caroline J. Cook
(Research Assistant)

B.A., Smith College. Coordinated the Global Burden of Disease Study versions 1 through 4 and developed the global burden of disease database.

Ms Catherine A. Fullerton
(Research Assistant)

B.A., Harvard University. Estimated global health research expenditures and provided estimates of the global burden of injury from falls.

Ms Emmanuela E. Gakidou
(Research Assistant)

B.A., Harvard University. Has studied the global burden of nephritis and nephrosis, chronic obstructive pulmonary disorder, and cirrhosis.

Mr Steven Goodreau
(Research Assistant)

B.A., Harvard University. Coordinated the Global Burden of Disease Study version 5 and has developed epidemiological estimates for burns and other injuries.

Dr Rafael Lozano
(Research Associate)

M.D., M.Sc. in epidemiology. Dr Lozano is a research scientist at the National Institute of Public Health in Mexico, investigator at the Mexican Health Foundation and Research Fellow at the Harvard Center for Population and Development Studies.

Dr Xinjian Qiao
(Research Associate)

Sc.D. in demography, Harvard University. Dr Qiao has specialized in analyzing and modelling causes of death.

Mr Joshua A. Salomon
(Research Assistant)

B.A., Harvard University. Has focused his research on tuberculosis epidemiology and projections of disease burden.

Mr Bonifasiyo K. Ssennyamantono
(Research Assistant)

B.A., Harvard University. Provided epidemiological estimates and validity checks for the Global Burden of Disease Study version 5.

Appendix B

Study schedule

Following is a list of the major meetings of the Ad Hoc Committee on Health Research Relating to Future Intervention Options, of its subcommittees and of its sponsors during the preparation and review of successive drafts of this Report.

10–11 March 1994 Geneva, Switzerland	First meeting of the WHO Ad Hoc Committee on Health Research Relating to Future Intervention Options
16–17 June 1994 Geneva, Switzerland	Scientific consultation on the “Social and Health Impact of Migration: Priorities for Research”
10–12 August, 1994 Cuernavaca, Mexico	Working Group II (Health Systems and Policy), first discussion meeting
30 September–5 October 1994 Los Angeles, USA	Meeting of informal drafting group (consisting of Ad Hoc Committee Chair and Co-Chair, representatives of the three working groups, and others associated with the review); Working Group II second discussion meeting
9–10 November 1994 New Delhi, India	Working Group III (Institutional Arrangements) discussion meeting
12 December 1994 London, U.K.	Discussion meeting with private sector representatives on “Stimulating R&D into Medicines for Developing Countries”
23 January–1 February 1995 Geneva, Switzerland	Meeting of informal drafting group (consisting of Ad Hoc Committee Chair and Co-Chair, representatives of the three working groups, and others associated with the review)
1 February 1995 Geneva, Switzerland	Working Group II, Subcommittee on Population Research
2–3 February 1995 Geneva, Switzerland	Working Group II, Subcommittee on Household Behaviour Research
9–10 March 1995 Geneva, Switzerland	Second meeting of the Ad Hoc Committee
10–11 April 1995 Cuernavaca, Mexico	Meeting of the Americas Subcommittee of the Ad Hoc Committee
5–6 June 1995 Osaka, Japan	Meeting of the Asian Subcommittee of the Ad Hoc Committee
29–30 June 1995 Geneva, Switzerland	Meeting of the European Subcommittee of the Ad Hoc Committee
6–8 August 1995 Geneva, Switzerland	Working Group I (Quantification of Burden), consultation on quantifying disability weights to assess non-fatal burden from disease and injury
11–13 September 1995 Cape Town, South Africa	Meeting of the African Subcommittee of the Ad Hoc Committee
20 October, 1995 Geneva, Switzerland	Planning meeting for R&D priorities concerning noncommunicable diseases and healthy aging

23–24 October 1995 London, UK	Meeting of Ad Hoc Committee sponsors, hosted by the Wellcome Trust and World Bank
14–15 March 1996 Neûchatel, Switzerland	Meeting of Ad Hoc Committee sponsors and others, hosted by the Swiss Development Co-operation Agency
19–20 March 1996 Washington, DC, USA	Joint meeting with International Health Policy Program on priorities for health policy research
27–29 June 1996 Geneva, Switzerland	Meeting of donors and other stakeholders to review final Report and discuss implementation of recommendations

Appendix C

Country composition and demographic projections for each of the eight regional groupings used in this Report

Table AC.1 Countries and areas included in each of the eight regional groupings used in this Report

<i>Demographically developed countries</i>	Croatia	Marshall Islands	Gabon
<i>Established market economies (EME)</i>	Czech Republic	Mauritius	Gambia, The
	Estonia	Micronesia, Federated States of	Ghana
	Hungary	Midway Island	Guinea
	Latvia	Mongolia	Guinea-Bissau
	Lithuania	Myanmar	Kenya
	Macedonia, Former Yugoslav Republic of	Nauru	Lesotho
Andorra	Moldova, Republic of	Nepal	Liberia
Australia	Poland	New Caledonia	Madagascar
Austria	Romania	Niue	Malawi
Belgium	Russian Federation	Northern Mariana Islands	Mali
Bermuda	Slovakia	Palau	Mauritania
Canada	Slovenia	Papua New Guinea	Mayotte
Channel Islands	Slovenia	Philippines	Mozambique
Denmark	Ukraine	Pitcairn Island	Namibia
Faeroe Islands	Yugoslavia	Reunion	Niger
Finland		Seychelles	Nigeria
France		Singapore	Rwanda
Germany		Solomon Islands	Sao Tome and Principe
Gibraltar		Sri Lanka	Senegal
Greece		Taiwan, China	Sierra Leone
Greenland		Thailand	Somalia
Holy See		Tokelau Island	South Africa
Iceland		Tonga	Saint Helena
Ireland		Tuvalu	Sudan
Isle of Man		Vanuatu	Swaziland
Italy		Viet Nam	Tanzania, United Republic of
Japan		Wake Island	Togo
Liechtenstein		Wallis and Futuna Islands	Tristan da Cunha
Luxembourg		Western Samoa	Uganda
Monaco			Zaire
Netherlands			Zambia
New Zealand			Zimbabwe
Norway			
Portugal			
San Marino			
Spain			
Saint Pierre and Miquelon			
Sweden			
Switzerland			
United Kingdom			
United States			
<i>Formerly socialist economies of Europe (FSE)</i>			
Albania			
Belarus			
Bosnia and Herzegovina			
Bulgaria			
	<i>Demographically developing countries</i>		
	<i>India</i>		
	<i>China</i>		
	<i>Other Asia and islands (OAI)</i>		
	American Samoa		
	Bangladesh		
	Bhutan		
	Brunei Darussalam		
	Cambodia		
	Cook Islands		
	Fiji		
	French Polynesia		
	Guam		
	Hong Kong		
	Indonesia		
	Johnston Island		
	Kiribati		
	Korea, Democratic People's Republic of		
	Korea, Republic of		
	Lao People's Democratic Republic		
	Macao		
	Malaysia		
	Maldives		
		<i>Sub-Saharan Africa (SSA)</i>	
		Angola	
		Ascension	
		Benin	
		Botswana	
		Burkina Faso	
		Burundi	
		Cameroon	
		Cape Verde	
		Central African Republic	
		Chad	
		Comoros	
		Congo	
		Côte d'Ivoire	
		Djibouti	
		Equatorial Guinea	
		Eritrea	
		Ethiopia	
			<i>Latin America and the Caribbean (LAC)</i>
			Anguilla
			Antigua and Barbuda
			Argentina
			Aruba
			Bahamas, The
			Barbados
			Belize
			Bolivia
			Brazil
			British Virgin Islands
			Cayman Islands
			Chile
			Colombia

Costa Rica	Panama	Armenia	Pakistan
Cuba	Paraguay	Azerbaijan	Qatar
Dominica	Peru	Bahrain	Saudi Arabia
Dominican Republic	Puerto Rico	Cyprus	Syrian Arab Republic
Ecuador	Saint Kitts and Nevis	Egypt	Tajikistan
El Salvador	Saint Lucia	Former Spanish Sahara	Tunisia
Falkland/Malvinas Islands	Saint Vincent and the Grenadines	Georgia	Turkey
French Guiana	Suriname	Iran, Islamic Republic of	Turkmenistan
Grenada	Trinidad and Tobago	Iraq	United Arab Emirates
Guadeloupe	Turks and Caicos Islands	Israel	Uzbekistan
Guatemala	Uruguay	Jordan	West Bank and Gaza
Guyana	U.S. Virgin Islands	Kazakhstan	Yemen
Haiti	Venezuela	Kuwait	
Honduras		Kyrgyzstan	
Jamaica		Lebanon	
Martinique	<i>Middle Eastern crescent</i>	Libyan Arab Jamahiriya	
Mexico	<i>(MEC)</i>	Malta	
Montserrat	Afghanistan	Morocco	
Netherlands Antilles	Algeria	Oman	
Nicaragua			

Table AC.2 Demographic characteristics of the regional groupings used in this Report—estimates for 1980 and 1990 and projections for 2020

Demographic characteristic	Established market economies			Formerly socialist economies of Europe			India			China		
	1980	1990	2020	1980	1990	2020	1980	1990	2020	1980	1990	2020
1. Population size (millions)												
Total	757	798	905	324	346	365	684	850	1 227	988	1 134	1 469
Age 0–4	52	51	57	27	27	24	97	116	102	97	118	110
Age 60+	127	145	245	45	57	80	42	59	124	73	101	213
2. Mortality indicators												
Total deaths (millions)	7.5	7.1	8.7	3.2	3.8	4.9	9.1	9.4	11.4	7.7	8.9	13.9
Deaths age 0–4 (millions)	0.2	0.1	0.0	0.3	0.1	0.1	3.9	3.3	1.0	1.4	1.1	0.3
Deaths age 60+ (millions)	6.2	5.9	7.5	2.3	2.7	3.7	2.7	3.3	6.5	3.7	5.4	9.8
Probability of dying before age 5 (%)	1.7	1.0	0.4	3.0	2.1	1.0	17.2	13.0	4.7	6.7	4.4	1.4
Life expectancy at birth (years)	74	77	83	71	70	72	55	58	66	63	68	72
Latin America and Caribbean												
Other Asia and islands												
Sub-Saharan Africa												
Middle Eastern crescent												
1. Population size (millions)												
Total	552	683	1 024	376	510	1 172	355	444	678	382	503	1 003
Age 0–4	82	86	86	69	95	177	52	56	57	62	81	120
Age 60+	31	43	118	17	23	59	21	31	84	20	29	78
2. Mortality indicators												
Total deaths (millions)	5.7	5.5	7.7	6.2	8.2	10.4	2.7	3.0	4.7	4.7	4.6	6.6
Deaths age 0–4 (millions)	2.2	1.6	0.6	3.3	4.0	2.9	0.9	0.7	0.3	2.1	1.9	1.1
Deaths age 60+ (millions)	1.6	2.0	4.7	0.9	1.3	3.0	0.9	1.2	2.9	1.1	1.4	3.4
Probability of dying before age 5 (%)	12.0	9.0	3.4	19.9	19.3	7.9	8.6	6.1	2.3	15.0	10.9	4.6
Life expectancy at birth (years)	58	63	71	49	49	61	65	68	74	56	62	69
Demographically developing countries												
World												
1. Population size (millions)												
Total	1 081	1 144	1 270	3 337	4 123	4 414	5 267	7 844				
Age 0–4	79	78	81	458	552	536	631	732				
Age 60+	172	202	325	204	286	371	488	1 002				
2. Mortality indicators												
Total deaths (millions)	10.7	10.9	13.5	36.2	39.6	46.9	50.5	68.3				
Deaths age 0–4 (millions)	0.5	0.2	0.1	13.9	12.5	14.4	12.8	6.3				
Deaths age 60+ (millions)	8.5	8.6	11.2	10.9	14.6	19.4	23.2	41.6				
Probability of dying before age 5 (%)	2.1	1.4	0.6	13.5	10.7	12.0	9.6	4.2				
Life expectancy at birth (years)	73	75	80	59	61	62	64	70				

Note: All projections to 2020 included high, medium and low variants. This table shows only the medium variant; the others appear in Murray & Lopez 1996. For infectious diseases (and hence for the probability of dying before age 5) the high and low variants differ quite substantially.

Source: For 1980, World Bank 1993; Annex table A.4:202–203; for 1990 and 2020, Murray & Lopez 1996.

Annex 1

Global patterns of cause of death and burden of disease in 1990, with projections to 2020

Christopher J. L. Murray and Alan D. Lopez

1.1 Introduction

Governments and other authorities charged with planning and formulating health policy—including policy for R&D—require reliable data on the nature, extent and distribution of diseases and health problems of their populations. However, despite decades of partial efforts, reliable, consistent information that can be compared between countries and regions has not been available. Indeed, even data on the numbers of deaths by specific causes have been highly unreliable because of the systematic tendency of disease-specific analysts to inflate, often substantially, the number of deaths attributable to the condition with which they are concerned.

Lopez (1993), in a chapter prepared for the World Bank's health sector priorities review (Jamison et al. 1993), provided an initial set of estimates of deaths by cause in demographically developing countries (for 1985) which were consistent with demographers' estimates of the total numbers of deaths. Providing internally consistent estimates of numbers of deaths by cause is a critical first step for informing health policy. But it is only a first step: assessments of the overall burden of disease should also take into account age at death and, even more so, disability caused by disease and injury.

In order to generate a fuller accounting of disease burden for its *World development report* on health, the World Bank commissioned a complete assessment of causes of death and disease burden by region for 1990. This assessment was undertaken by the Harvard Center for Population and Development Studies and the World Health Organization with the active involvement of scholars from around the world. Initial results appear in the *World development report* (World Bank 1993); a slightly revised version was published in 1994 together with descriptions of the underlying methods and sensitivity analyses (Murray 1994; Murray & Lopez 1994a; Murray & Lopez 1994b; Murray, Lopez & Jamison 1994).

To underpin the analyses for the present Report, the Ad Hoc Committee commissioned an extensive reassessment and extension of the original burden of disease study.¹ In addition to revising estimates of disease bur-

den by cause, age, sex and region for 1990, the study contains significant new material including projections of disease burden until 2020, and estimates of the proportion of disease burden that can be attributed to selected risk factors for disease (such as tobacco, alcohol and hypertension). This annex describes the methods used and summarizes the main results of the 1990 estimates (and the projections to 2020) of numbers of deaths by cause of disease burden; Annex 2 summarizes comparable results for selected risk factors.

1.2 Measuring disease burden

Traditional mortality data are inadequate for the needs of decision-makers even when the quality of the data is good, because they fail to capture the impact of serious but non-fatal conditions on a population's health needs. In order to overcome this problem, a measure known as the disability-adjusted life year (DALY) has been used. Because the DALY captures the impact of long-term disability as well as premature death, it provides information that is strikingly absent from traditional mortality statistics. For example, the number of *deaths* from psychiatric and neurological diseases in 1990 was about 1% of the world total. However, this group of diseases accounted for more than 10% of the global disease burden when measured in disability-adjusted life years, which capture both death and disability. To illustrate the differences between measures in one region, Table A1.1 shows the top ranking causes of disease burden in sub-Saharan Africa, according to whether the ranking is

1. The data shown in this Report summarize the results of the study. The complete data, together with full details of the methods and materials used, are published as companion volumes to this Report under the general title of the Global Burden of Disease and Injury Series, edited by C.J.L. Murray and A. D. Lopez (see in particular the first volume of this 10-volume series, Murray & Lopez 1996).

based on deaths alone, years of life lost (YLLs), or years of healthy life lost (DALYs).²

Another advantage of the DALY is that it can be used to measure the outcome of interventions for specific health problems, in terms of the number of DALYs averted by applying a particular intervention. Thus the relative cost-effectiveness of different interventions can be assessed.

Each DALY indicates the loss of a year's healthy life—that is, time lived with a disability or time lost through premature death. The number of DALYs in different regions, and from different conditions, in any single year provides a guide to the relative distribution of disease burden. The higher the number of DALYs, the greater the burden. Thus, for example, the number of DALYs per 1000 people in sub-Saharan Africa in 1990 was about five times greater than in the established market economies (EMEs). Regional differences in the prevalence of specific diseases can also be shown: for example, psychiatric and neurological diseases accounted for 4% of the disease burden in sub-Saharan Africa, but almost 25% of the burden in the EMEs; by contrast, respiratory infections accounted for just over 10% of the burden in sub-Saharan Africa, but only 1% of the burden in the EMEs.

The DALY construct involves explicit underlying assumptions. This explicitness makes it possible to undertake "sensitivity analyses" of how estimates of disease burden vary with respect to age weighting, discount rates and disability weights. Such analyses show a slight effect on estimates of disease burden, but the effects are small over the reasonable range of assumptions. Extension and exploration of the DALY concept continues. For example, some potential lines of change explicitly introduce burden associated with late fetal death and would increase the estimated relative burden of noncommunicable diseases in developing countries.

By 1995, at least 28 countries were using either the DALY or a locally modified version of it to assess disease burden and plan health interventions. These include eight countries in sub-Saharan Africa, five in Asia, four in the Middle East and North Africa, six in Latin America and the Caribbean, and five in the formerly socialist economies of Europe.

1.2.1 Methods

As a starting point for the assessment, demographic estimates of population and deaths by five-year age groups and by sex were developed for each of eight regions (World Bank 1993). In order to assess disease burden, epidemiologists classified the available data on deaths worldwide in 1990 according to the international classification of diseases, injuries and cause of death categorized by the World Health Organization (World Health Organization 1977), subdividing by age, sex and

the eight demographic regions: China (CHI); the established market economies (EME); the formerly socialist economies of Europe (FSE); India (IND); Latin America and the Caribbean (LAC); the Middle Eastern crescent (including North Africa, the Middle East, Pakistan, and the Central Asian republics of the former Soviet Union) (MEC); other Asia and islands (OAI); and sub-Saharan Africa (SSA). The criteria for defining these regional groupings included the level of socioeconomic development, epidemiological homogeneity and geographic contiguity.

The sources of data on deaths vary in quality and type from region to region. Four basic types have been used: vital registration systems, sample death registration systems, epidemiological assessments and cause-of-death models. Only the EME and the FSE regions have complete vital registration systems. For the demographically developing regions, other sources, including sample registration systems, population laboratories, epidemiological estimates and models, were used to supplement information from vital registration. In China and India, some limited but reliable data exist. In China, a representative sample of 10 million people in rural and urban areas has been monitored since the early 1980s, enabling estimates of mortality by cause to be made. In India, two limited systems allow for wider estimates to be made: the first is an urban record of medically certified deaths for Maharashtra State; the second is a sample registration system based on "verbal autopsy"³ in primary health care centres in rural areas. The latter is useful only for assigning deaths to broad categories.

In other developing regions, some vital registration data are available but they fail to capture most deaths and are unlikely to be representative. In these cases, we have relied more on epidemiological estimates and models of cause of death. A full discussion of the sources of data and the sequential procedure we have followed to estimate mortality for each region is provided in Murray and Lopez (1996).

To calculate disease burden in DALYs, data on premature mortality and disability are combined. The number of years of life lost is assessed as the difference between the actual age at death and the age to which the person could have been expected to live from that age, given the mortality levels of an advanced industrialized country, that is, expectation at birth of 82.5 years for women and 80 for men. Next, the incidence of disability due to disease or injury within both genders, and each age and demographic region, is estimated from the available information within each community and from expert opinion. The expected duration of the disabling condition—to remission or death—is multiplied by a weighting factor that allows the severity of the condition to be taken into account. For example, a severely disabling condition that stops the person from doing basic

2. The tables for Annex 1 begin on page 140.

3. "Verbal autopsy" is a procedure for assigning a cause of death based on interviews with the family or relatives of the deceased about symptoms present at or around the time of death.

activities, such as eating unaided, was assigned more weight than a condition that limits solely one non-essential activity such as recreation. Finally, discounting and age-weighting systems were incorporated to allow future years of life to become gradually less valuable, and involved assigning different relative values to years at different stages in a person's life. A year of life in infancy is relatively low in value, rises rapidly to age 25, when the person is likely to have older and younger dependents, and then declines slowly.

1.2.2 Defining, categorizing and summarizing disease burden

In total, 500 different conditions or sequelae of disease have been separately evaluated. These have been grouped into 96 detailed causes and in addition a variety of cause groups or clusters. This list of causes encompasses those that are likely to be of significant public health importance in any region. Tables A1.2 to A1.4 rank the 96 causes for 1990, and Tables A1.5 to A1.7 offer our estimate of their ranking in 2020. Table A1.8 presents this same data in alphabetical order by condition for 1990 and 2020 so that the reader can see the projected change in ranking for a particular condition over time.

All assessed causes meet one or more of the following criteria:

- the condition is epidemiologically significant, affecting large numbers of people;
- the condition requires a significant amount of health service provision (e.g. appendicitis);
- the condition is a significant factor in current health policy debates, including, for example, diseases that are expected to be eliminated as public health problems in the foreseeable future, such as leprosy.

The whole group of diseases and conditions has been categorized according to a so-called tree structure. At the first level of disaggregation, overall mortality is divided into three broad cause groups:

- Group I, consisting of communicable diseases, maternal causes, conditions arising in the perinatal period and nutritional deficiencies;
- Group II, consisting of the noncommunicable diseases; and
- Group III, consisting of all types of injury, unintentional or otherwise.

The diseases and health problems in Group I are typically prevalent in a population at early stages of the epidemiological transition, when infant and child mortality rates remain high, fertility is high and life expectancy low. Group I conditions typically decline at a faster pace than all-cause mortality during the process of epidemiological transition, so that in a population with high life expectancy, these conditions are comparatively rare.

By contrast, the diseases and conditions in Group II

are the commonest health problems in populations that have undergone epidemiological transition. While it is true that mortality rates from some noncommunicable causes such as stomach cancer may decline faster than mortality from all causes, these conditions have been maintained in Group II along with other cancers, since death rates from cancer as a whole appear to be relatively constant throughout the transition.

Injuries are classified as a separate group because their etiology is very different from that of most diseases, but also because there is no generalized pattern of change in injury mortality that accompanies the epidemiological transition.

Within each group, causes of disease burden are further subdivided as shown in Tables A1.9 and A1.10. These tables summarize the data; more detailed causes are shown in complete form in Murray and Lopez (1996 and forthcoming: vols. 1–7). Table A1.9 provides an overview of the global burden of disease in 1990 by region, and breaks this down further by its impact on males and females; Table A1.10 offers a projection of the same conditions for 2020.

1.3 Projecting deaths by cause, 1990–2020

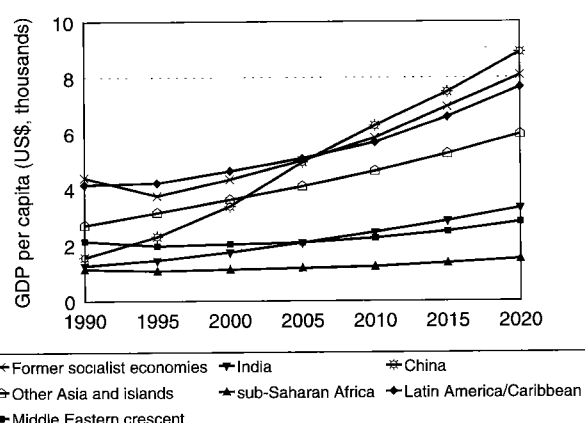
At a time of rapid social and demographic change and rising health care costs, governments need to be able to plan for their populations' future needs as accurately as possible. For this reason, this review incorporates a set of projections for important causes of death and disease burden until 2020. The projection method is described fully elsewhere (Murray & Lopez 1996). Briefly, a statistical or econometric model was used to predict different scenarios of cause-specific mortality based on just four independent variables. These are:

- income per capita;
- human capital (average number of years of schooling in a population);
- smoking intensity; and
- time.

This model is simplistic, but its virtue is that it generates plausible predictions based largely on empirical observations across a wide range of countries over many decades.

Income per capita is chosen because it is a useful proxy for many aspects of economic development and is closely associated with life expectancy. Thus, for example, if income per capita in China is projected to increase by x over the next 25 years, life expectancy is expected to rise too by y and Group I conditions are expected to fall by z . Human capital is a second important indicator because it is a powerful determinant of health status. The greater the level of education in a population (particularly the education of females) the more rapidly its members are able to gain access to new information related to

Figure A1.1 Projected income per capita to 2020, demographically developing countries and formerly socialist economies



health and adapt their behaviours accordingly. Projected income per capita for the demographically developing and formerly socialist countries to 2020 is shown in Figure A1.1. We have omitted the established market economies from this graph as it would distort the scale too much to see the trends. We project average per capita income for the established market economies growing from US\$ 14 876 in 1995 to US\$ 31 651 in 2020.

Smoking intensity has been included as a variable because tobacco is a major determinant of adult mortality, accounting for more than one-third of all deaths in middle age in countries at the peak of their tobacco-related epidemics of disease. The fourth variable—time—is a crude proxy for changes in technology or education. Thus, for example, immunization programmes may be viewed as having had a secular impact on child survival, a concept captured in our projections by this variable.

Rather than apply this model to total disease burden and then disaggregate the resulting total by causes, we have applied it independently to separate groups of causes and then summed them for each age group and for both sexes. This approach is likely to reflect better the impact of the four specific independent variables than an aggregated model. We have generated three projections of deaths for baseline, optimistic and pessimistic assumptions, by making three different sets of projections for GDP growth, human capital and smoking trends. Death by cause data for 1990 are shown in Table A1.11, and our projections are shown in Tables A1.12, A1.13, and A1.14.

1.4 Future health trends: factors contributing to the changing distribution of disease burden

Two separate processes determine trends in the distribution of disease burden. The relationship between these two processes is often confused. It is important, however, that they should be clearly distinguished.

The first is the demographic transition which is under way in most low-income and middle-income regions. As fertility falls, a decline in mortality follows, and the population ages. The proportion of the population that is adult (both young adults and older adults) increases sharply, so the *proportion* of the total disease burden in the population that is due to adult conditions, largely noncommunicable diseases, also rises. Thus, for example, the burden of cardiovascular disease in India increases from just over 8% of the total in 1990 to just over 17% in 2020. During this period the proportion of the population over the age of 15 is projected to increase from 63% to 74% (Murray & Lopez 1996). This process leads to an increase in the *number* of cases of noncommunicable diseases, but not to a change in the *rates* of those diseases in any specific age group.

The second process is inherently more complex. It concerns the way in which people's exposure to certain known risk factors for noncommunicable diseases (such as tobacco, high-fat diets and alcohol) is increasing in many regions, while in some low-income countries risk factors for some communicable diseases have been reduced.

The epidemiological impact of such changes on future disease burden is very difficult to assess. While it is possible to predict a massive rise in smoking-related deaths in the coming 25 years due to a rapid increase in tobacco use in demographically developing countries over the past few decades, the epidemiological effects of changing exposure to other established risk factors for specific diseases are less certain. This is because much less is reliably known about the hazards of these risk factors in different populations and because of the potential impact of secular socioeconomic changes and developments in technology. Annex 2 in this Report provides details of the methods used for assessing the proportion of current disease burden that is attributable to specific risk factors and a discussion of the problems inherent in projecting future burden due to those factors.

In the industrialized countries, there have been some dramatic changes in mortality from several of the major noncommunicable diseases over the past few decades. Death rates from coronary heart disease and stroke, for example, have been declining in most Western industrialized countries, but have been rising in Eastern Europe. Lung cancer mortality among men is now declining in many countries, most notably in Finland and the United Kingdom, but is rising for women, most notably in the United States, as the full effects of past smoking patterns become evident. There has been relatively little

change in mortality from other major cancers, with some rates rising and some declining.

Meanwhile, there has been progress in controlling some of the environmental factors that increase populations' risks of Group I conditions such as diarrhoeal diseases. Safe water and adequate sanitation are being extended to more of the population in low-income countries, and access to immunization and other technical interventions, such as oral rehydration, has expanded.

Thus, the projected changes in disease burden from 1990 to 2020 are determined by the interaction of a growing and aging population with changes in the projected levels of some of the major historical determinants of health—income and education levels, levels of a few key risk factors (as described above), and a secular trend towards improvement that reflects, in part, the steady growth of knowledge. Change in DALYs can be divided into two components: the increase or decrease expected due simply to a change in the size and distribution of the population (demographic), and the increase or decrease that can be expected due to changes in age-specific DALY rates (epidemiological). Thus demographic variation projects existing rates of risk factors for age and sex cohorts, and the projected change derives from variation in the cohorts' size and age distribution, principally the aging of populations with the concurrent increase in the incidence of noncommunicable disease. Epidemiological variation, in contrast, presumes a change in risk factors or in how treatment would affect DALY outcomes, assuming no change in the age distribution of populations; for example, an expected increase in the numbers of teenagers who smoke. We have calculated the change in DALYs that would occur if 1990 age-specific DALY rates were applied to the population projected to 2020 (labelled "demographic" change in Figure A1.2), and the change in DALYs that would occur if 2020 DALY rates are applied to 1990 populations.

Figure A1.2 illustrates the change in *absolute numbers* of DALYs for Groups I, II and III in each region and worldwide from 1990 to 2020. Look, for example, at the upper left frame in Figure A1.2. This shows the changes in *total* DALYs in the world for Group I conditions, and it shows how large total change would be if there were only demographic or only epidemiological change (columns 2 and 3). Note that the effects are *not* additive: epidemiological change plus demographic change does not equal total changes. Note, too, that the projected change in the total DALYs in the world—resulting from a decrease in Group I DALYs and increases in Group II and III DALYs—is very modest over the 30 years despite a population increase of over 50%.

1.4.1 Disease burden in 2020: projected trends

In all regions, DALYs from Group I are projected to decline. This reduction is driven by declining rates over recent decades and in fact is partly offset by population growth. In the demographically developing regions, Group II DALYs are projected to increase due to an ag-

ing population and stagnant, or slightly declining, death rates. The Group III burden will decline in the established market economies and the former socialist economies because of decreasing age-specific DALY rates, while Group III will increase in the demographically developing world because of demographic shifts expanding the number of young adults at high risk for injuries such as motor vehicle accidents.

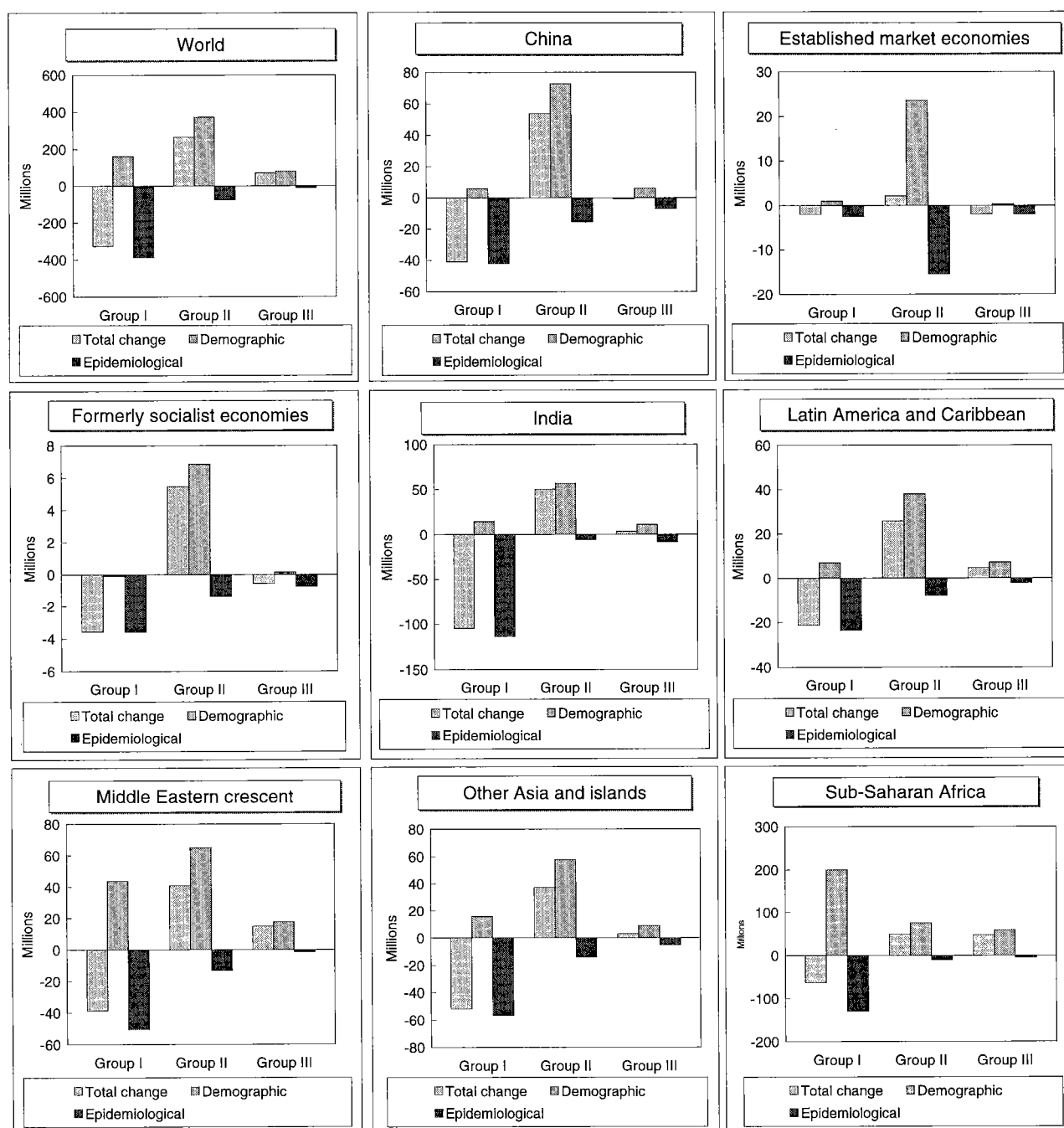
The projected decline in Group I conditions can be explained as follows. Observations from countries with good vital registration systems in the established market economies, Latin America and the Caribbean, and parts of Asia between 1950 and 1990 suggest that, with the exception of HIV and tuberculosis, age-specific death rates from Group I causes have steadily declined. This decline is a function of rising income, increasing education and technological improvements. As income, educational attainment and technology are all expected to continue to improve over the next 30 years, the projected burden from Group I will also continue to decline. Even in sub-Saharan Africa, modest income growth and rises in educational attainment, combined with an expectation that research and development investment will continue to generate new technologies, will lead to a steady decline in child mortality and Group I conditions. During the 1980s, child mortality in sub-Saharan Africa declined substantially, despite negative growth in income per capita in many parts of the region.

1.4.2 Special cases

Because these models are based on simple economic variables, they do not, in general, take into account specific scenarios relating to changes in communicable-disease pathogens. For example, we do not take into account the possibility of spreading drug resistance in microbes causing diseases with a major public health impact, such as tuberculosis, malaria or pneumococcus. While there is evidence that drug-resistant strains of these diseases are spreading, there is no clear evidence that mortality from these conditions is rising due to the spread of drug resistance. The possibility clearly remains, however, that technological progress will not keep pace with the development of resistance, and the case-fatality rates for some of these conditions at the global level could rise. If the rise in case-fatality rates were higher than the decline in incidence due to socioeconomic development and public health action, then mortality rates could increase. This frightening possibility cannot be ignored. Our projections, however, provide estimates of probable scenarios based on empirical observation. So far, the evidence has not accumulated to demonstrate that mortality from these conditions will increase due to drug resistance. Tuberculosis incidence is rising in some regions, such as the established market economies, but this is likely due to immigration policy, transmission in high-risk groups such as the homeless or injecting drug users, and the HIV epidemic.

The HIV epidemic is new, and the historical vital reg-

Figure A1.2 Change in DALYs by region, 1990–2020



Group 1: Communicable, maternal, perinatal and nutritional conditions
 Group 2: Noncommunicable diseases
 Group 3: Injuries

Demographic: projects effects of changes in population size and age distribution.
 Epidemiological: projects effects of changes in age-specific DALY rates as a result of changes in risk factors or treatments.

istration data from 1950 to 1990 do not adequately capture its development. A separate projection model has therefore been used for HIV. HIV projections have been calculated on estimates made by the WHO Global Programme on AIDS (GPA) and provided to the Ad Hoc Committee. For the phase of the epidemic where incidence is declining, the GPA projection model assumes that incidence falls to zero very quickly in all regions, such that by the year 2020 there would be essentially little or no incidence of HIV. This scenario appears to be too optimistic. Our projections are based on the assumption that incidence will decline to an equilibrium value that is one-half of peak incidence. The base scenario projections are based on this crude assumption. To estimate mortality from HIV, we have used the same assumptions as included in the GPA projection model on the time distribution of progression from HIV to AIDS and the distribution of death from AIDS over time. Because of the interaction between HIV and tuberculosis, we have modified the basic projections for tuberculosis in two regions where there is currently or projected to be a high prevalence of both diseases: sub-Saharan Africa and India. For sub-Saharan Africa, we assume in the baseline projections that the incidence rate of tuberculosis in the HIV-negative population will stay constant until 2010 and then begin to decline at a rate of 1% per year. For India, we assume that incidence will stay constant until 2000 and then decline at 2% per year.

Forecasting the course of the AIDS epidemic is complex; there are competing forecasting models, and the results among them often differ substantially. We put forth these projections as both plausible and consistent with the best available evidence concerning the state of the epidemic today. We wish to make clear, however, that the range of plausible alternative projections is large. We are much more confident that our burden estimates for 1990 provide a fair distillation of available epidemiological data.

1.5 Discussion

Through the application of a coherent model of disease occurrence, prevalence, mortality and remission, the estimates presented here for each disease and injury are both internally consistent and consistent with what is known about their natural history. On the other hand, the *validity* of the estimates varies substantially across diseases because of variation in the quality and coverage of the underlying epidemiological literature. By applying several different methods, we have tried to confirm the plausibility of the estimates. However, no amount of methodological rigour can compensate for poor datasets and lack of epidemiological monitoring. For large populations, including much of sub-Saharan Africa, India, other Asia and islands, and parts of Latin America and the Caribbean, there are important gaps in what is reliably known about the causes of mortality, and indeed about disease incidence, prevalence and duration. For other re-

gions, more data are available and there is proportionately more confidence in the estimates, but even for the industrialized regions, diagnostic and other differences in coding practices between countries cast doubt on the reliability of estimates for specific conditions.

Rather than limit this assessment to regions or conditions for which reasonably reliable data are available, it was decided to prepare a truly global assessment based on the best currently available data. We are fully aware of the substantial degree of uncertainty underlying many of the estimates; indeed, the data shortcomings this exercise has revealed point to the urgent need to improve the epidemiological information systems which underlie them so that national health status assessment can be performed and health development policies made more effective.

As a consequence of the strengthening of national health statistics systems, future global assessments will undoubtedly become more reliable, and thus more useful. In the meantime, we hope that the estimates and projections presented here will be used, critically reviewed and in due course updated on the basis of these reviews and critiques.

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Professor Christopher J. L. Murray has served as Chair of the WHO Tuberculosis Options Research Committee since 1992 and was Chair of Working Group I of the Ad Hoc Committee on Health Research Relating to Future Intervention Options Harvard Center for Population and Development Studies Roger and Ellen Reville Building 9 Bow Street Cambridge, MA 02138 USA
tel: (1-617) 495-8498
fax: (1-617) 496-3227

Dr Alan D. Lopez is Director of the World Health Organization Programme on Substance Abuse
World Health Organization
20, Avenue Appia
CH-1211 Geneva 27, Switzerland
tel: (41-22) 791-2374
fax: (41-22) 791-4851

Annex 1 tables

Table A1.1 Sub-Saharan Africa, 1990, leading causes of deaths, years of life lost (YLLs) and DALYs

	Deaths			YLLs			DALYs		
	Rank	Total deaths (1000s)	% total	Rank	Total YLLs (1000s)	% total	Rank	Total DALYs (1000s)	% total
All causes		8 202	100.00		226 890	100.00		295 294	100.00
Lower respiratory infections	1	1 006	12.26	2	29 533	13.02	2	30 221	10.23
Diarrhoeal diseases	2	950	11.59	1	31 393	13.84	1	32 126	10.88
Malaria	3	732	8.92	3	24 385	10.75	3	27 089	9.17
Measles	4	576	7.02	4	19 923	8.78	4	19 943	6.75
Perinatal conditions	5	503	6.13	5	17 150	7.56	5	19 314	6.54
Tuberculosis	6	386	4.70	6	9 434	4.16	7	10 184	3.45
Cerebrovascular disease	7	383	4.67	13	4 244	1.87	13	4 595	1.56
War	8	268	3.26	7	8 125	3.58	6	10 698	3.62
HIV	9	239	2.91	8	7 020	3.09	8	8 370	2.83
Ischaemic heart disease	10	209	2.55	17	2 095	0.92	21	2 367	0.80
Violence	11	205	2.50	9	6 008	2.65	9	6 576	2.23
Road-traffic accidents	12	155	1.89	11	4 668	2.06	10	5 729	1.94
Pertussis	13	148	1.81	10	5 093	2.24	11	5 529	1.87
Protein-energy malnutrition	16	102	1.24	14	3 285	1.45	12	5 424	1.84
Congenital anomalies	23	55	0.66	19	1 799	0.79	16	3 936	1.33
Falls	42	18	0.22	38	416	0.18	22	2 126	0.72
Iron-deficiency anaemia	52	12	0.15	43	306	0.13	20	2 565	0.87
Alcohol use	64	5	0.06	66	71	0.03	28	1 766	0.60
Gonorrhoea	67	4	0.04	61	105	0.05	27	1 769	0.60

Note: Rankings are in reference to the 96 conditions listed in tables A1.2 through A1.8 ranked here for sub-Saharan Africa.

Table A1.2 Causes of DALYs in 1990, by magnitude, world

Rank	Cause	DALYs (1000s)	% total
	All causes	1 379 238	100.00
1	Lower respiratory infections	112 898	8.19
2	Diarrhoeal diseases	99 633	7.22
3	Perinatal conditions	92 313	6.69
4	Unipolar major depression	50 810	3.68
5	Ischaemic heart disease	46 699	3.39
6	Cerebrovascular disease	38 523	2.79
7	Tuberculosis	38 426	2.79
8	Measles	36 520	2.65
9	Road-traffic accidents	34 317	2.49
10	Congenital anomalies	32 921	2.39
11	Malaria	31 706	2.30
12	Chronic obstructive pulmonary disease	29 136	2.11
13	Falls	26 680	1.93
14	Iron-deficiency anaemia	24 613	1.78
15	Protein-energy malnutrition	20 957	1.52
16	War	20 019	1.45
17	Self-inflicted injuries	18 967	1.38
18	Tetanus	17 517	1.27
19	Violence	17 472	1.27
20	Alcohol use	16 661	1.21
21	Drowning	15 697	1.14
22	Bipolar disorder	14 257	1.03
23	Pertussis	13 403	0.97
24	Osteoarthritis	13 278	0.96
25	Cirrhosis of the liver	13 182	0.96
26	Schizophrenia	12 798	0.93
27	Fires	11 875	0.86
28	HIV	11 172	0.81
29	Diabetes mellitus	11 103	0.80
30	Asthma	10 775	0.78
31	Inflammatory heart diseases	10 322	0.75
32	Obsessive-compulsive disorders	10 213	0.74
33	Tracheal, bronchial and lung cancers	8 871	0.64
34	Nephritis and nephrosis	8 607	0.62
35	Dementia and other degenerative CNS disorders	8 500	0.62
36	Stomach cancer	7 694	0.56
37	Cataracts	7 510	0.54
38	Chlamydia	7 169	0.52
39	Syphilis	6 596	0.48
40	Liver cancer	6 550	0.47
41	Obstructed labour	6 462	0.47
42	Poisoning	6 455	0.47
43	Bacterial meningitis and meningococcaemia	6 242	0.45
44	Rheumatic heart disease	6 191	0.45
45	Drug use	5 675	0.41
46	Maternal sepsis	5 452	0.40
47	Epilepsy	5 350	0.39
48	Abortion	5 097	0.37
49	Gonorrhoea	4 909	0.36
50	Panic disorder	4 766	0.35
51	Colon and rectal cancers	4 617	0.33
52	Leukaemia	4 567	0.33
53	Dental caries	4 313	0.31
54	Breast cancer	4 210	0.31
55	Lymphatic filariasis	3 997	0.29
56	Vitamin A deficiency	3 838	0.28
57	Mouth and oropharyngeal cancers	3 743	0.27
58	Oesophageal cancer	3 578	0.26
59	Maternal haemorrhage	3 564	0.26
60	Polio	3 371	0.24
61	Rheumatoid arthritis	3 286	0.24

(Table A1.2 continued)

Rank	Cause	DALYs (1000s)	% total
62	Lymphoma	3 104	0.23
63	Cervix uteri cancer	2 854	0.21
64	Edentulism	2 787	0.20
65	Peptic ulcer	2 766	0.20
66	Glaucoma	2 578	0.19
67	Otitis media	2 163	0.16
68	Hepatitis B and hepatitis C	2 136	0.15
69	Leishmaniasis	2 092	0.15
70	Post-traumatic stress disorder	1 945	0.14
71	Benign prostatic hypertrophy	1 818	0.13
72	Trichuriasis	1 788	0.13
73	Appendicitis	1 763	0.13
74	Ascariasis	1 750	0.13
75	Hypertensive disorders of pregnancy	1 731	0.13
76	Pancreatic cancer	1 577	0.11
77	Iodine deficiency	1 562	0.11
78	Schistosomiasis	1 519	0.11
79	Ancylostomiasis and necatoriasis	1 484	0.11
80	Trypanosomiasis	1 467	0.11
81	Multiple sclerosis	1 417	0.10
82	Ovarian cancer	1 403	0.10
83	Prostate cancer	1 345	0.10
84	Upper respiratory infections	1 311	0.10
85	Bladder cancer	1 215	0.09
86	Parkinson disease	1 050	0.08
87	Trachoma	1 024	0.07
88	Onchocerciasis	884	0.06
89	Dengue	750	0.05
90	Japanese encephalitis	744	0.05
91	Corpus uteri cancer	644	0.05
92	Chagas disease	641	0.05
93	Melanoma and other skin cancers	565	0.04
94	Leprosy	384	0.03
95	Diphtheria	361	0.03
96	Periodontal disease	255	0.02

Table A1.3 Causes of DALYs in 1990, by magnitude, established market economies and formerly socialist economies of Europe

Rank	Cause	DALYs (1000s)	% total
	All causes	160 994	100.00
1	Ischaemic heart disease	15 950	9.91
2	Unipolar major depression	9 780	6.07
3	Cerebrovascular disease	9 425	5.85
4	Road-traffic accidents	7 064	4.39
5	Alcohol use	6 446	4.00
6	Osteoarthritis	4 681	2.91
7	Tracheal, bronchial and lung cancers	4 587	2.85
8	Dementia and other degenerative CNS disorders	3 816	2.37
9	Self-inflicted injuries	3 768	2.34
10	Congenital anomalies	3 480	2.16
11	Chronic obstructive pulmonary disease	3 365	2.09
12	Perinatal conditions	3 120	1.94
13	Schizophrenia	3 106	1.93
14	Diabetes mellitus	3 022	1.88
15	Bipolar disorder	2 543	1.58
16	Falls	2 448	1.52
17	Lower respiratory infections	2 392	1.49
18	Cirrhosis of the liver	2 345	1.46
19	Colon and rectal cancers	2 298	1.43
20	Obsessive-compulsive disorders	2 098	1.30
21	Stomach cancer	2 084	1.29
22	Drug use	2 053	1.28
23	Breast cancer	1 930	1.20
24	Violence	1 840	1.14
25	Asthma	1 734	1.08
26	Rheumatoid arthritis	1 426	0.89
27	HIV	1 308	0.81
28	Poisoning	1 181	0.73
29	War	1 151	0.71
30	Inflammatory heart diseases	1 150	0.71
31	Iron-deficiency anaemia	1 149	0.71
32	Panic disorder	996	0.62
33	Lymphoma	949	0.59
34	Leukaemia	900	0.56
35	Epilepsy	884	0.55
36	Drowning	877	0.55
37	Pancreatic cancer	871	0.54
38	Nephritis and nephrosis	721	0.45
39	Prostate cancer	682	0.42
40	Dental caries	647	0.40
41	Chlamydia	645	0.40
42	Edentulism	644	0.40
43	Mouth and oropharyngeal cancers	596	0.37
44	Parkinson disease	574	0.36
45	Ovarian cancer	565	0.35
46	Rheumatic heart disease	545	0.34
47	Bladder cancer	519	0.32
48	Liver cancer	510	0.32
49	Tuberculosis	496	0.31
50	Diarrhoeal diseases	465	0.29
51	Oesophageal cancer	461	0.29
52	Fires	452	0.28
53	Peptic ulcer	442	0.27
54	Bacterial meningitis and meningococcaemia	409	0.25
55	Post-traumatic stress disorder	387	0.24
56	Obstructed labour	386	0.24
57	Cervix uteri cancer	378	0.24
58	Multiple sclerosis	357	0.22
59	Melanoma and other skin cancers	349	0.22
60	Corpus uteri cancer	318	0.20

(Table A1.3 continued)

Rank	Cause	DALYs (1000s)	% total
61	Benign prostatic hypertrophy	317	0.20
62	Protein-energy malnutrition	199	0.12
63	Abortion	170	0.11
64	Maternal sepsis	141	0.09
65	Otitis media	132	0.08
66	Gonorrhoea	121	0.08
67	Glaucoma	100	0.06
68	Hepatitis B and hepatitis C	91	0.06
69	Upper respiratory infections	79	0.05
70	Cataracts	67	0.04
71	Appendicitis	54	0.03
72	Periodontal disease	52	0.03
73	Pertussis	50	0.03
74	Iodine deficiency	41	0.03
75	Maternal haemorrhage	33	0.02
76	Hypertensive disorders of pregnancy	25	0.01
77	Measles	22	0.01
78	Syphilis	10	0.01
79	Polio	4	0.00
80	Tetanus	3	0.00
81	Malaria	2	0.00
82	Leprosy	1	0.00
83	Leishmaniasis	1	0.00
84	Diphtheria	1	0.00
85	Japanese encephalitis	0	0.00
86	Schistosomiasis	0	0.00
87	Trypanosomiasis	0	0.00
88	Trachoma	0	0.00
89	Vitamin A deficiency	0	0.00
90	Ancylostomiasis and necatoriasis	0	0.00
91	Dengue	0	0.00
92	Trichuriasis	0	0.00
93	Ascariasis	0	0.00
94	Onchocerciasis	0	0.00
95	Chagas disease	0	0.00
96	Lymphatic filariasis	0	0.00

Note: Values of 0.00 denote conditions smaller than .01.

Table A1.4 Causes of DALYs in 1990, by magnitude, demographically developing countries

Rank	Cause	DALYs (1000s)	% total
	All causes	1 218 244	100.00
1	Lower respiratory infections	110 506	9.07
2	Diarrhoeal diseases	99 168	8.14
3	Perinatal conditions	89 193	7.32
4	Unipolar major depression	41 031	3.37
5	Tuberculosis	37 930	3.11
6	Measles	36 498	3.00
7	Malaria	31 705	2.60
8	Ischaemic heart disease	30 749	2.52
9	Congenital anomalies	29 441	2.42
10	Cerebrovascular disease	29 099	2.39
11	Road-traffic accidents	27 253	2.24
12	Chronic obstructive pulmonary disease	25 771	2.12
13	Falls	24 232	1.99
14	Iron-deficiency anaemia	23 465	1.93
15	Protein-energy malnutrition	20 758	1.70
16	War	18 868	1.55
17	Tetanus	17 513	1.44
18	Violence	15 632	1.28
19	Self-inflicted injuries	15 199	1.25
20	Drowning	14 819	1.22
21	Pertussis	13 353	1.10
22	Bipolar disorder	11 714	0.96
23	Fires	11 424	0.94
24	Cirrhosis of the liver	10 837	0.89
25	Alcohol use	10 214	0.84
26	HIV	9 864	0.81
27	Schizophrenia	9 692	0.80
28	Inflammatory heart diseases	9 172	0.75
29	Asthma	9 042	0.74
30	Osteoarthritis	8 597	0.71
31	Obsessive-compulsive disorders	8 114	0.67
32	Diabetes mellitus	8 080	0.66
33	Nephritis and nephrosis	7 886	0.65
34	Cataracts	7 443	0.61
35	Syphilis	6 586	0.54
36	Chlamydia	6 524	0.54
37	Obstructed labour	6 076	0.50
38	Liver cancer	6 039	0.50
39	Bacterial meningitis and meningococcaemia	5 833	0.48
40	Rheumatic heart disease	5 645	0.46
41	Stomach cancer	5 610	0.46
42	Maternal sepsis	5 311	0.44
43	Poisoning	5 274	0.43
44	Abortion	4 928	0.40
45	Gonorrhoea	4 788	0.39
46	Dementia and other degenerative CNS disorders	4 684	0.38
47	Epilepsy	4 466	0.37
48	Tracheal, bronchial and lung cancers	4 285	0.35
49	Lymphatic filariasis	3 997	0.33
50	Vitamin A deficiency	3 838	0.32
51	Panic disorder	3 770	0.31
52	Leukaemia	3 667	0.30
53	Dental caries	3 665	0.30
54	Drug use	3 622	0.30
55	Maternal haemorrhage	3 531	0.29
56	Polio	3 368	0.28
57	Mouth and oropharyngeal cancers	3 148	0.26
58	Oesophageal cancer	3 117	0.26
59	Glaucoma	2 478	0.20
60	Cervix uteri cancer	2 476	0.20
61	Peptic ulcer	2 323	0.19

(Table A1.4 continued)

Rank	Cause	DALYs (1000s)	% total
62	Colon and rectal cancers	2 319	0.19
63	Breast cancer	2 280	0.19
64	Lymphoma	2 154	0.18
65	Edentulism	2 143	0.18
66	Leishmaniasis	2 091	0.17
67	Hepatitis B and hepatitis C	2 045	0.17
68	Otitis media	2 031	0.17
69	Rheumatoid arthritis	1 860	0.15
70	Trichuriasis	1 788	0.15
71	Ascariasis	1 750	0.14
72	Appendicitis	1 709	0.14
73	Hypertensive disorders of pregnancy	1 707	0.14
74	Post-traumatic stress disorder	1 558	0.13
75	Iodine deficiency	1 520	0.12
76	Schistosomiasis	1 519	0.12
77	Benign prostatic hypertrophy	1 500	0.12
78	Ancylostomiasis and necatoriasis	1 484	0.12
79	Trypanosomiasis	1 467	0.12
80	Upper respiratory infections	1 233	0.10
81	Multiple sclerosis	1 061	0.09
82	Trachoma	1 024	0.08
83	Onchocerciasis	884	0.07
84	Ovarian cancer	838	0.07
85	Dengue	750	0.06
86	Japanese encephalitis	744	0.06
87	Pancreatic cancer	707	0.06
88	Bladder cancer	696	0.06
89	Prostate cancer	663	0.05
90	Chagas disease	641	0.05
91	Parkinson disease	476	0.04
92	Leprosy	382	0.03
93	Diphtheria	360	0.03
94	Corpus uteri cancer	325	0.03
95	Melanoma and other skin cancers	216	0.02
96	Periodontal disease	203	0.02

Table A1.5 Causes of DALYs in 2020, by magnitude, world

Rank	Cause	DALYs (1000s)	% total
	All causes	1 388 836	100.00
1	Ischaemic heart disease	82 325	5.93
2	Unipolar major depression	78 662	5.66
3	Road-traffic accidents	71 240	5.13
4	Cerebrovascular disease	61 392	4.42
5	Chronic obstructive pulmonary disease	57 587	4.15
6	Lower respiratory infections	42 692	3.07
7	Tuberculosis	42 515	3.06
8	War	41 315	2.97
9	Diarrhoeal diseases	37 097	2.67
10	HIV	36 317	2.61
11	Perinatal conditions	34 755	2.50
12	Violence	31 262	2.25
13	Congenital anomalies	30 986	2.23
14	Self-inflicted injuries	25 928	1.87
15	Tracheal, bronchial and lung cancers	25 626	1.85
16	Osteoarthritis	24 026	1.73
17	Alcohol use	22 983	1.65
18	Bipolar disorder	21 227	1.53
19	Falls	21 195	1.53
20	Schizophrenia	17 332	1.25
21	Cirrhosis of the liver	16 418	1.18
22	Stomach cancer	16 049	1.16
23	Cataracts	15 890	1.14
24	Malaria	15 596	1.12
25	Measles	15 443	1.11
26	Obsessive-compulsive disorders	14 869	1.07
27	Liver cancer	14 749	1.06
28	Dementia and other degenerative CNS disorders	14 656	1.06
29	Asthma	13 246	0.95
30	Drowning	12 367	0.89
31	Fires	11 776	0.85
32	Inflammatory heart diseases	11 671	0.84
33	Diabetes mellitus	10 805	0.78
34	Oesophageal cancer	8 164	0.59
35	Drug use	7 979	0.57
36	Colon and rectal cancers	7 810	0.56
37	Protein-energy malnutrition	7 798	0.56
38	Mouth and oropharyngeal cancers	7 670	0.55
39	Iron-deficiency anaemia	7 522	0.54
40	Nephritis and nephrosis	7 374	0.53
41	Panic disorder	7 165	0.52
42	Poisoning	6 628	0.48
43	Rheumatic heart disease	6 628	0.48
44	Dental caries	6 360	0.46
45	Breast cancer	6 084	0.44
46	Leukaemia	5 878	0.42
47	Tetanus	5 802	0.42
48	Glaucoma	5 785	0.42
49	Edentulism	5 675	0.41
50	Pertussis	5 348	0.39
51	Rheumatoid arthritis	5 210	0.38
52	Cervix uteri cancer	5 184	0.37
53	Lymphoma	5 019	0.36
54	Benign prostatic hypertrophy	3 838	0.28
55	Epilepsy	3 601	0.26
56	Peptic ulcer	3 219	0.23
57	Chlamydia	2 824	0.20
58	Syphilis	2 755	0.20
59	Post-traumatic stress disorder	2 750	0.20
60	Pancreatic cancer	2 710	0.20
61	Prostate cancer	2 677	0.19

(Table A1.5 continued)

Rank	Cause	DALYs (1000s)	% total
62	Bladder cancer	2 394	0.17
63	Gonorrhoea	2 306	0.17
64	Ovarian cancer	1 991	0.14
65	Parkinson disease	1 865	0.13
66	Bacterial meningitis and meningococcaemia	1 826	0.13
67	Multiple sclerosis	1 818	0.13
68	Vitamin A deficiency	1 242	0.09
69	Polio	1 084	0.08
70	Corpus uteri cancer	967	0.07
71	Obstructed labour	920	0.07
72	Appendicitis	893	0.06
73	Lymphatic filariasis	846	0.06
74	Melanoma and other skin cancers	844	0.06
75	Maternal sepsis	807	0.06
76	Abortion	748	0.05
77	Otitis media	602	0.04
78	Hepatitis B and hepatitis C	576	0.04
79	Trachoma	549	0.04
80	Maternal haemorrhage	535	0.04
81	Upper respiratory infections	475	0.03
82	Ancylostomiasis and necatoriasis	462	0.03
83	Schistosomiasis	460	0.03
84	Periodontal disease	416	0.03
85	Trichuriasis	414	0.03
86	Trypanosomiasis	411	0.03
87	Ascariasis	397	0.03
88	Iodine deficiency	397	0.03
89	Leishmaniasis	360	0.03
90	Onchocerciasis	301	0.02
91	Hypertensive disorders of pregnancy	273	0.02
92	Chagas disease	175	0.01
93	Leprosy	128	0.01
94	Japanese encephalitis	116	0.01
95	Diphtheria	110	0.01
96	Dengue	110	0.01

Table A1.6 Causes of DALYs in 2020, by magnitude, established market economies and formerly socialist economies of Europe

Rank	Cause	DALYs (1000s)	% total
	All causes	160 534	100.00
1	Ischaemic heart disease	17 997	11.21
2	Cerebrovascular disease	9 875	6.15
3	Unipolar major depression	9 825	6.12
4	Tracheal, bronchial and lung cancers	7 253	4.52
5	Road-traffic accidents	6 852	4.27
6	Alcohol use	6 088	3.79
7	Osteoarthritis	5 580	3.48
8	Dementia and other degenerative CNS disorders	5 506	3.43
9	Chronic obstructive pulmonary disease	4 910	3.06
10	Self-inflicted injuries	3 879	2.42
11	Schizophrenia	2 820	1.76
12	Colon and rectal cancers	2 710	1.69
13	Stomach cancer	2 671	1.66
14	Cirrhosis of the liver	2 622	1.63
15	Diabetes mellitus	2 480	1.54
16	Bipolar disorder	2 438	1.52
17	HIV	2 355	1.47
18	Obsessive-compulsive disorders	2 051	1.28
19	Falls	1 995	1.24
20	Drug use	1 873	1.17
21	Violence	1 790	1.11
22	Breast cancer	1 733	1.08
23	Congenital anomalies	1 661	1.03
24	Rheumatoid arthritis	1 654	1.03
25	Asthma	1 628	1.01
26	Lower respiratory infections	1 585	0.99
27	Perinatal conditions	1 135	0.71
28	War	1 125	0.70
29	Pancreatic cancer	1 049	0.65
30	Inflammatory heart diseases	1 039	0.65
31	Lymphoma	995	0.62
32	Panic disorder	981	0.61
33	Prostate cancer	964	0.60
34	Poisoning	938	0.58
35	Leukaemia	881	0.55
36	Parkinson disease	830	0.52
37	Edentulism	782	0.49
38	Mouth and oropharyngeal cancers	770	0.48
39	Bladder cancer	697	0.43
40	Dental caries	682	0.43
41	Liver cancer	617	0.38
42	Nephritis and nephrosis	615	0.38
43	Drowning	586	0.36
44	Oesophageal cancer	583	0.36
45	Ovarian cancer	514	0.32
46	Epilepsy	511	0.32
47	Peptic ulcer	498	0.31
48	Iron-deficiency anaemia	495	0.31
49	Rheumatic heart disease	463	0.29
50	Benign prostatic hypertrophy	442	0.28
51	Post-traumatic stress disorder	378	0.24
52	Melanoma and other skin cancers	366	0.23
53	Cervix uteri cancer	332	0.21
54	Fires	312	0.19
55	Corpus uteri cancer	301	0.19
56	Multiple sclerosis	292	0.18
57	Chlamydia	254	0.16
58	Tuberculosis	150	0.09

(Table A1.6 continued)

Rank	Cause	DALYs (1000s)	% total
59	Glaucoma	139	0.09
60	Diarrhoeal diseases	137	0.09
61	Bacterial meningitis and meningococcaemia.	119	0.07
62	Cataracts	79	0.05
63	Protein-energy malnutrition	78	0.05
64	Periodontal disease	51	0.03
65	Obstructed labour	50	0.03
66	Gonorrhoea	50	0.03
67	Appendicitis	42	0.03
68	Otitis media	38	0.02
69	Upper respiratory infections	31	0.02
70	Hepatitis B and hepatitis C	27	0.02
71	Abortion	21	0.01
72	Maternal sepsis	18	0.01
73	Pertussis	12	0.01
74	Measles	6	0.00
75	Maternal haemorrhage	4	0.00
76	Syphilis	4	0.00
77	Hypertensive disorders of pregnancy	3	0.00
78	Polio	2	0.00
79	Tetanus	1	0.00
80	Leprosy	0	0.00
81	Malaria	0	0.00
82	Leishmaniasis	0	0.00
83	Diphtheria	0	0.00
84	Schistosomiasis	0	0.00
85	Trachoma	0	0.00
86	Trypanosomiasis	0	0.00
87	Vitamin A deficiency	0	0.00
88	Lymphatic filariasis	0	0.00
89	Chagas disease	0	0.00
90	Onchocerciasis	0	0.00
91	Iodine deficiency	0	0.00
92	Japanese encephalitis	0	0.00
93	Ascariasis	0	0.00
94	Trichuriasis	0	0.00
95	Ancylostomiasis and necatoriasis	0	0.00
96	Dengue	0	0.00

Note: Values of 0.00 denote conditions smaller than .01.

Table A1.7 Causes of DALYs in 2020, by magnitude, demographically developing countries

Rank	Cause	DALYs (1000s)	% total
	All causes	1 228 302	100.00
1	Unipolar major depression	68 837	5.60
2	Road-traffic accidents	64 388	5.24
3	Ischaemic heart disease	64 328	5.24
4	Chronic obstructive pulmonary disease	52 677	4.29
5	Cerebrovascular disease	51 518	4.19
6	Tuberculosis	42 364	3.45
7	Lower respiratory infections	41 107	3.35
8	War	40 190	3.27
9	Diarrhoeal diseases	36 960	3.01
10	HIV	33 962	2.76
11	Perinatal conditions	33 620	2.74
12	Violence	29 472	2.40
13	Congenital anomalies	29 325	2.39
14	Self-inflicted injuries	22 048	1.80
15	Falls	19 200	1.56
16	Bipolar disorder	18 789	1.53
17	Osteoarthritis	18 446	1.50
18	Tracheal, bronchial and lung cancers	18 373	1.50
19	Alcohol use	16 895	1.38
20	Cataracts	15 811	1.29
21	Malaria	15 595	1.27
22	Measles	15 437	1.26
23	Schizophrenia	14 512	1.18
24	Liver cancer	14 132	1.15
25	Cirrhosis of the liver	13 796	1.12
26	Stomach cancer	13 378	1.09
27	Obsessive-compulsive disorders	12 818	1.04
28	Drowning	11 781	0.96
29	Asthma	11 618	0.95
30	Fires	11 464	0.93
31	Inflammatory heart diseases	10 631	0.87
32	Dementia and other degenerative CNS disorders	9 150	0.74
33	Diabetes mellitus	8 326	0.68
34	Protein-energy malnutrition	7 720	0.63
35	Oesophageal cancer	7 581	0.62
36	Iron-deficiency anaemia	7 027	0.57
37	Mouth and oropharyngeal cancers	6 900	0.56
38	Nephritis and nephrosis	6 759	0.55
39	Panic disorder	6 184	0.50
40	Rheumatic heart disease	6 164	0.50
41	Drug use	6 106	0.50
42	Tetanus	5 801	0.47
43	Poisoning	5 690	0.46
44	Dental caries	5 677	0.46
45	Glaucoma	5 646	0.46
46	Pertussis	5 336	0.43
47	Colon and rectal cancers	5 101	0.42
48	Leukaemia	4 997	0.41
49	Edentulism	4 893	0.40
50	Cervix uteri cancer	4 852	0.40
51	Breast cancer	4 352	0.35
52	Lymphoma	4 024	0.33
53	Rheumatoid arthritis	3 555	0.29
54	Benign prostatic hypertrophy	3 396	0.28
55	Epilepsy	3 090	0.25
56	Syphilis	2 751	0.22
57	Peptic ulcer	2 720	0.22
58	Chlamydia	2 570	0.21
59	Post-traumatic stress disorder	2 372	0.19
60	Gonorrhoea	2 256	0.18

(Table A1.7 continued)

Rank	Cause	DALYs (1000s)	% total
61	Prostate cancer	1 713	0.14
62	Bacterial meningitis and meningococcaemia	1 707	0.14
63	Bladder cancer	1 697	0.14
64	Pancreatic cancer	1 661	0.14
65	Multiple sclerosis	1 526	0.12
66	Ovarian cancer	1 477	0.12
67	Vitamin A deficiency	1 242	0.10
68	Polio	1 082	0.09
69	Parkinson disease	1 035	0.08
70	Obstructed labour	869	0.07
71	Appendicitis	851	0.07
72	Lymphatic filariasis	846	0.07
73	Maternal sepsis	789	0.06
74	Abortion	727	0.06
75	Corpus uteri cancer	666	0.05
76	Otitis media	564	0.05
77	Hepatitis B and hepatitis C	549	0.04
78	Trachoma	549	0.04
79	Maternal haemorrhage	531	0.04
80	Melanoma and other skin cancers	478	0.04
81	Ancylostomiasis and necatoriasis	462	0.04
82	Schistosomiasis	460	0.04
83	Upper respiratory infections	443	0.04
84	Trichuriasis	414	0.03
85	Trypanosomiasis	411	0.03
86	Ascariasis	397	0.03
87	Iodine deficiency	397	0.03
88	Periodontal disease	366	0.03
89	Leishmaniasis	359	0.03
90	Onchocerciasis	301	0.02
91	Hypertensive disorders of pregnancy	270	0.02
92	Chagas disease	175	0.01
93	Leprosy	128	0.01
94	Japanese encephalitis	116	0.01
95	Dengue	110	0.01
96	Diphtheria	110	0.01

Table A1.8 Causes of DALYs in 1990 and 2020, listed alphabetically for world, established market economies and formerly socialist economies of Europe, and demographically developing regions, of 96 conditions

Cause	1990						2020					
	World			EME + FSE			World			EME + FSE		
	Rank	% total	Dem. dev.	Rank	% total	Dem. dev.	Rank	% total	Dem. dev.	Rank	% total	Dem. dev.
Abortion	48	0.37		63	0.11		44	0.40		71	0.01	
Alcohol use	20	1.21		5	4.00		25	0.84		6	3.79	
Ancylostomiasis and necatoriasis	79	0.11		91	0.00		78	0.12		95	0.00	
Appendicitis	73	0.13		71	0.03		72	0.14		67	0.03	
Ascariasis	74	0.13		90	0.00		71	0.14		93	0.00	
Asthma	30	0.78		25	1.08		29	0.74		25	1.01	
Bacterial meningitis and meningococcaemia	43	0.45		54	0.25		39	0.48		61	0.07	
Benign prostatic hypertrophy	71	0.13		61	0.20		77	0.12		50	0.28	
Bipolar disorder	22	1.03		15	1.58		22	0.96		16	1.52	
Bladder cancer	85	0.09		47	0.32		88	0.06		39	0.43	
Breast cancer	54	0.31		23	1.20		63	0.19		22	1.08	
Cataracts	37	0.54		70	0.04		34	0.61		62	0.05	
Cerebrovascular disease	6	2.79		3	5.85		10	2.39		2	6.15	
Cervix uteri cancer	63	0.21		57	0.24		60	0.20		53	0.21	
Chagas disease	92	0.05		94	0.00		90	0.05		89	0.00	
Chlamydia	38	0.52		41	0.40		36	0.54		57	0.16	
Chronic obstructive pulmonary disease	12	2.11		11	2.09		12	2.12		9	3.06	
Cirrhosis of the liver	25	0.96		18	1.46		24	0.89		14	1.63	
Colon and rectal cancers	51	0.33		19	1.43		62	0.19		12	1.69	
Congenital anomalies	10	2.39		10	2.16		9	2.42		23	1.03	
Corpus uteri cancer	91	0.05		60	0.20		94	0.03		55	0.19	
Dementia*	35	0.62		8	2.37		46	0.38		8	3.43	
Dengue	89	0.05		96	0.00		85	0.06		96	0.00	
Dental caries	53	0.31		40	0.40		53	0.30		40	0.43	
Diabetes mellitus	29	0.80		14	1.88		32	0.66		15	1.54	
Diarrhoeal diseases	2	7.22		50	0.29		2	8.14		60	0.09	
Diphtheria	95	0.03		84	0.00		93	0.03		83	0.00	
Drowning	21	1.14		36	0.55		20	1.22		43	0.36	
Drug use	45	0.41		22	1.28		54	0.30		20	1.17	
Edentulism	64	0.20		42	0.40		65	0.18		37	0.49	
Epilepsy	47	0.39		35	0.55		47	0.37		46	0.32	
Falls	13	1.93		16	1.52		13	1.99		19	1.24	
Fires	27	0.86		52	0.28		23	0.94		54	0.19	
Glaucoma	66	0.19		67	0.06		59	0.20		59	0.09	
Gonorrhoea	49	0.36		66	0.08		45	0.39		66	0.03	
Hepatitis B and hepatitis C	68	0.15		68	0.06		67	0.17		70	0.02	
HIV	28	0.81		27	0.81		26	0.81		17	1.47	
Hypertensive disorders of pregnancy	75	0.13		76	0.02		73	0.14		77	0.00	
Inflammatory heart diseases	31	0.75		30	0.71		28	0.75		30	0.65	
Iodine deficiency	77	0.11		74	0.03		75	0.12		91	0.00	

(Table A1.8 continued)

Cause	1990						2020					
	World			EME + FSE			World			EME + FSE		
	Dem. dev.			Dem. dev.			Dem. dev.			Dem. dev.		
	Rank	%	total	Rank	%	total	Rank	%	total	Rank	%	total
Iron-deficiency anaemia	14	1.78	0.71	31	1.93	0.54	39	0.31	0.57	48	0.31	0.57
Ischaemic heart disease	5	3.39	9.91	1	2.52	5.93	1	11.21	3	5.24	11.21	3
Japanese encephalitis	90	0.05	0.00	85	0.06	0.01	94	0.00	0.01	94	0.00	0.01
Leishmaniasis	69	0.15	0.00	83	0.17	0.03	89	0.00	0.03	82	0.00	0.03
Leprosy	94	0.03	0.00	82	0.03	0.01	93	0.00	0.01	80	0.00	0.01
Leukaemia	52	0.33	0.56	34	0.30	0.42	46	0.55	0.41	35	0.55	0.41
Liver cancer	40	0.47	0.32	48	0.50	1.06	27	0.38	1.15	41	0.38	1.15
Lower respiratory infections	1	8.19	1.49	17	9.07	3.07	6	0.99	7	3.35	0.99	7
Lymphatic filariasis	55	0.29	0.00	89	0.33	0.06	73	0.00	0.07	88	0.00	0.07
Lymphoma	62	0.23	0.59	33	0.18	0.36	53	0.62	0.33	31	0.62	0.33
Malaria	11	2.30	0.00	81	2.60	1.12	24	0.00	1.27	81	0.00	1.27
Maternal haemorrhage	59	0.26	0.02	75	0.29	0.04	80	0.00	0.04	75	0.00	0.04
Maternal sepsis	46	0.40	0.09	64	0.44	0.06	75	0.01	0.06	72	0.01	0.06
Measles	8	2.65	0.01	77	3.00	1.11	25	0.00	1.26	74	0.00	1.26
Melanoma and other skin cancers	93	0.04	0.22	59	0.02	0.06	74	0.23	0.04	52	0.23	0.04
Mouth and oropharyngeal cancers	57	0.27	0.37	43	0.26	0.55	38	0.48	0.56	37	0.48	0.56
Multiple sclerosis	81	0.10	0.22	58	0.09	0.13	67	0.18	0.12	56	0.18	0.12
Nephritis and nephrosis	34	0.62	0.45	38	0.65	0.53	40	0.38	0.55	42	0.38	0.55
Obsessive-compulsive disorders	32	0.74	1.30	20	0.67	1.07	26	1.28	1.04	18	1.28	1.04
Obstructed labour	41	0.47	0.24	56	0.50	0.07	71	0.03	0.07	65	0.03	0.07
Oesophageal cancer	58	0.26	0.29	51	0.26	0.59	34	0.36	0.62	44	0.36	0.62
Onchocerciasis	88	0.06	0.00	95	0.07	0.02	90	0.00	0.02	90	0.00	0.02
Osteoarthritis	24	0.96	2.91	6	0.71	1.73	16	3.48	1.50	7	3.48	1.50
Otitis media	67	0.16	0.08	65	0.17	0.04	68	0.02	0.05	76	0.02	0.05
Ovarian cancer	82	0.10	0.35	45	0.07	0.14	77	0.32	0.12	45	0.32	0.12
Pancreatic cancer	76	0.11	0.54	37	0.06	0.20	64	0.65	0.14	29	0.65	0.14
Panic disorder	50	0.35	0.62	32	0.31	0.52	41	0.61	0.50	39	0.61	0.50
Parkinson disease	86	0.08	0.36	44	0.04	0.13	65	0.52	0.08	36	0.52	0.08
Peptic ulcer disease	65	0.20	0.27	53	0.19	0.23	47	0.31	0.22	57	0.31	0.22
Perinatal conditions	3	6.69	1.94	12	7.32	2.50	11	0.71	2.74	11	0.71	2.74
Periodontal disease	96	0.02	0.03	72	0.02	0.03	84	0.03	0.03	88	0.03	0.03
Pertussis	23	0.97	0.73	21	1.10	0.39	50	0.01	0.43	46	0.01	0.43
Poisoning	42	0.47	0.73	28	0.43	0.48	42	0.58	0.46	34	0.58	0.46
Polio	60	0.24	0.00	79	0.28	0.08	69	0.00	0.09	78	0.00	0.09
Post-traumatic stress disorder	70	0.14	0.24	55	0.13	0.20	59	0.24	0.19	51	0.24	0.19
Prostate cancer	83	0.10	0.42	39	0.05	0.19	61	0.60	0.14	61	0.60	0.14
Protein-energy malnutrition	15	1.52	0.12	62	1.70	0.56	37	0.05	0.63	34	0.05	0.63
Rheumatic heart disease	44	0.45	0.34	46	0.46	0.48	43	0.29	0.50	49	0.29	0.50
Rheumatoid arthritis	61	0.24	0.89	26	0.15	0.38	24	1.03	0.29	53	1.03	0.29
Road-traffic accidents	9	2.49	4.39	4	2.24	5.13	5	4.27	5.24	2	4.27	5.24
Schistosomiasis	78	0.11	0.00	86	0.12	0.03	84	0.00	0.04	82	0.00	0.04

(Table A1.8 continued)

Cause	1990						2020					
	World			EME + FSE			World			EME + FSE		
	Rank	%	total	Rank	%	total	Rank	%	total	Rank	%	total
Schizophrenia	26	0.93		13	1.93		20	1.25		11	1.76	
Self-inflicted injuries	17	1.38		9	2.34		14	1.87		10	2.42	
Stomach cancer	36	0.56		21	1.29		22	1.16		13	1.66	
Syphilis	39	0.48		78	0.01		58	0.20		76	0.00	
Tetanus	18	1.27		80	0.00		47	0.42		79	0.00	
Tracheal, bronchial, and lung cancers	33	0.64		7	2.85		15	1.85		4	4.52	
Trachoma	87	0.07		88	0.00		79	0.04		85	0.00	
Trichuriasis	72	0.13		92	0.00		85	0.03		94	0.00	
Trypanosomiasis	80	0.11		87	0.00		86	0.03		86	0.00	
Tuberculosis	7	2.79		49	0.31		7	3.06		58	0.09	
Unipolar major depression	4	3.68		2	6.07		2	5.66		3	6.12	
Upper respiratory infections	84	0.10		69	0.05		81	0.10		69	0.02	
Violence	19	1.27		24	1.14		12	2.25		21	1.11	
Vitamin A deficiency	56	0.28		93	0.00		68	0.09		87	0.00	
War	16	1.45		29	0.71		8	2.97		28	0.70	

*Includes other degenerative and hereditary CNS disorders

Table A1.9 Global burden of disease in 1990, disaggregated by region, cause and gender

Condition	DALYs by cause, as percentage of regional total											
	World				Sub-Saharan Africa				India			
	All	Male	Female	All	Male	Female	All	Female	Male	Female	All	Male
Total DALYs (1000s)	1 379 238	722 032	657 206	295 294	154 602	140 692	287 739	142 190	145 549	208 407	108 652	99 755
I. Communicable, maternal, perinatal and nutritional conditions	43.9	40.7	47.4	65.9	62.0	70.2	56.4	53.8	59.0	24.2	22.0	26.6
A. Infectious and parasitic diseases	22.9	22.6	23.2	42.5	41.8	43.3	28.9	29.9	27.9	7.5	7.7	7.2
1. Tuberculosis	2.8	3.0	2.5	3.4	3.1	3.8	4.8	6.2	3.4	2.0	2.3	1.7
2. STDs excluding HIV	1.4	0.9	1.9	2.1	1.5	2.8	1.9	1.3	2.5	0.1	0.0	0.1
3. HIV	0.8	0.8	0.8	2.8	2.5	3.2	0.1	0.1	0.1	0.0	0.0	0.0
4. Diarrhoeal diseases	7.2	7.2	7.3	10.9	11.2	10.6	10.2	9.9	10.6	1.8	1.6	1.9
5. Childhood-cluster diseases	5.2	5.1	5.3	10.3	10.2	10.4	6.4	6.4	6.3	1.1	1.1	1.1
6. Bacterial meningitis and meningococcaemia	0.5	0.4	0.5	0.3	0.3	0.4	0.5	0.5	0.5	0.6	0.6	0.6
7. Malaria	2.3	2.3	2.3	9.2	9.3	9.0	0.4	0.4	0.4	0.0	0.0	0.0
8. Tropical cluster diseases and leprosy	0.8	1.0	0.6	1.9	2.2	1.5	1.2	1.6	0.7	0.1	0.2	0.0
9. Intestinal nematode infections	0.4	0.4	0.4	0.2	0.2	0.2	0.3	0.3	0.3	0.7	0.7	0.7
10. Other infectious and parasitic diseases	1.7	1.6	1.8	1.4	1.3	1.4	3.1	3.1	3.1	1.2	1.2	1.1
B. Respiratory infections	8.5	8.2	8.7	10.5	10.8	10.1	11.9	11.3	12.5	5.9	5.3	6.6
1. Lower respiratory infections	8.2	8.0	8.4	10.2	10.6	9.8	11.4	11.0	11.9	5.7	5.1	6.4
2. Other respiratory infections	0.3	0.2	0.3	0.2	0.2	0.2	0.5	0.3	0.6	0.2	0.2	0.2
C. Maternal conditions	2.2	0.0	4.5	3.2	0.0	6.8	2.6	0.0	5.1	1.3	0.0	2.6
1. Obstructed labour	0.5	0.0	1.0	0.6	0.0	1.2	0.5	0.0	1.0	0.3	0.0	0.6
2. Abortion	0.4	0.0	0.8	0.6	0.0	1.2	0.6	0.0	1.1	0.0	0.0	0.1
3. Other maternal conditions	1.3	0.0	2.8	2.1	0.0	4.4	1.5	0.0	3.0	0.9	0.0	2.0
D. Perinatal conditions	6.7	6.6	6.8	6.5	6.4	6.7	8.8	8.8	8.9	4.9	4.6	5.3
E. Nutritional deficiencies	3.7	3.3	4.1	3.2	3.0	3.4	4.2	3.9	4.6	4.6	4.5	4.7
1. Protein-energy malnutrition	1.5	1.4	1.6	1.8	1.8	1.9	1.8	1.7	1.8	1.0	0.8	1.2
2. Vitamin A deficiency and iodine deficiency	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4
3. Iron-deficiency anaemia	1.8	1.5	2.1	0.9	0.8	1.0	2.1	1.8	2.4	3.2	3.3	3.1
4. Other nutritional deficiencies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
II. Noncommunicable diseases	40.9	40.5	41.4	18.8	18.0	19.6	29.0	29.6	28.4	58.2	58.3	58.0
A. Malignant neoplasms	5.1	5.4	4.8	2.1	2.2	2.0	2.5	2.3	2.6	8.7	10.4	6.8
1. Stomach cancer	0.6	0.7	0.4	0.1	0.1	0.1	0.2	0.2	0.1	1.6	2.0	1.2
2. Colon and rectal cancers	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5
3. Liver cancer	0.5	0.7	0.3	0.3	0.4	0.1	0.1	0.1	0.0	1.9	2.8	1.0
4. Tracheal, bronchial and lung cancers	0.6	0.9	0.3	0.1	0.1	0.0	0.1	0.2	0.0	1.0	1.3	0.6
5. Breast cancer	0.3	0.0	0.6	0.1	0.0	0.2	0.2	0.0	0.4	0.2	0.0	0.4
6. Cervix uteri cancer	0.2	0.0	0.4	0.1	0.0	0.3	0.3	0.0	0.5	0.1	0.0	0.3
7. Lymphomas and multiple myelomas	0.2	0.3	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.2	0.2	0.1
8. Leukaemia	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.2	0.1	0.8	0.8	0.8
9. Other malignant neoplasms	2.0	2.2	1.8	1.1	1.1	0.9	1.3	1.4	1.2	2.4	2.8	2.0

(Table A1.9 continued)

Condition	World			Sub-Saharan Africa			India			China		
	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female
B. Diabetes mellitus	0.8	0.7	0.9	0.2	0.2	0.2	0.8	0.8	0.8	0.5	0.5	0.6
C. Neuropsychiatric conditions	10.5	10.0	11.1	4.0	3.7	4.4	7.0	6.6	7.4	14.2	12.6	15.9
1. Unipolar major depression	3.7	2.5	5.0	1.5	1.0	2.1	2.8	2.1	3.5	6.2	4.4	8.2
2. Bipolar disorder	1.0	1.0	1.1	0.4	0.4	0.5	0.8	0.8	0.8	1.8	1.8	1.8
3. Schizophrenia	0.9	0.9	0.9	0.2	0.2	0.2	0.6	0.6	0.5	1.3	1.3	1.2
4. Alcohol use	1.2	2.0	0.3	0.6	0.9	0.2	0.3	0.6	0.1	0.7	1.3	0.1
5. Dementia and other CNS disorders	0.6	0.5	0.7	0.1	0.1	0.2	0.3	0.3	0.4	0.7	0.7	0.8
6. Drug use	0.4	0.6	0.2	0.1	0.2	0.0	0.0	0.0	0.0	0.1	0.2	0.0
7. Epilepsy	0.4	0.4	0.4	0.2	0.2	0.2	0.3	0.4	0.3	0.4	0.5	0.4
8. Other neuropsychiatric conditions	2.2	1.9	2.6	0.9	0.8	1.0	1.8	1.7	1.9	2.9	2.5	3.3
D. Glaucoma and cataracts	0.8	0.7	0.9	0.7	0.6	0.7	1.0	1.0	1.0	1.0	0.8	1.2
E. Cardiovascular diseases	9.7	9.7	9.6	3.9	3.4	4.5	8.1	8.6	7.7	11.0	11.2	10.7
1. Rheumatic heart disease	0.4	0.4	0.5	0.2	0.2	0.3	0.5	0.4	0.6	1.1	0.9	1.3
2. Ischaemic heart disease	3.4	3.7	3.1	0.8	0.7	0.9	3.5	3.9	3.1	2.9	3.0	2.7
3. Cerebrovascular disease	2.8	2.7	2.9	1.6	1.3	1.8	1.5	1.5	1.4	5.2	5.4	4.9
4. Inflammatory heart diseases	0.7	0.7	0.8	0.5	0.4	0.6	0.6	0.6	0.6	0.6	0.6	0.6
5. Other cardiovascular diseases	2.3	2.3	2.3	0.9	0.8	0.9	2.0	2.1	1.9	1.1	1.2	1.1
F. Respiratory diseases	4.4	4.5	4.2	2.6	2.7	2.4	2.6	2.7	2.6	10.7	11.1	10.2
1. Chronic obstructive pulmonary disease	2.1	2.3	2.0	0.6	0.7	0.5	0.9	1.0	0.8	8.5	8.8	8.3
2. Asthma	0.8	0.8	0.7	0.5	0.5	0.5	0.5	0.6	0.5	1.3	1.4	1.2
3. Other respiratory diseases	1.5	1.5	1.5	1.5	1.5	1.5	1.3	1.2	1.3	0.8	0.9	0.7
G. Digestive diseases	3.4	3.8	3.1	1.8	1.9	1.7	2.2	2.8	1.6	4.9	5.2	4.6
1. Cirrhosis of the liver	1.0	1.3	0.6	0.2	0.3	0.1	1.0	1.4	0.6	1.5	2.0	1.0
2. Other digestive diseases	2.5	2.5	2.5	1.6	1.7	1.6	1.2	1.4	1.0	3.4	3.3	3.6
H. Musculo-skeletal diseases	1.4	1.0	1.8	0.4	0.2	0.5	0.5	0.4	0.6	1.7	1.1	2.3
1. Rheumatoid arthritis	0.2	0.1	0.4	0.0	0.0	0.0	0.1	0.0	0.1	0.3	0.2	0.4
2. Osteoarthritis	1.0	0.7	1.2	0.3	0.2	0.4	0.4	0.4	0.5	1.0	0.7	1.4
3. Other musculo-skeletal diseases	0.2	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.5
I. Congenital anomalies	2.4	2.3	2.5	1.3	1.2	1.4	2.9	2.9	2.9	3.0	2.8	3.2
J. Oral conditions	0.5	0.5	0.6	0.1	0.1	0.1	0.4	0.4	0.4	0.5	0.5	0.5
K. Other noncommunicable diseases	2.0	2.0	2.0	1.6	1.6	1.5	0.9	1.0	0.8	2.1	2.2	2.0
III. Injuries	15.1	18.7	11.2	15.4	20.1	10.1	14.6	16.6	12.6	17.6	19.6	15.4
A. Unintentional injuries	11.0	13.8	8.0	9.3	12.2	6.2	13.0	14.9	11.2	12.9	15.7	9.9
1. Road-traffic accidents	2.5	3.5	1.4	1.9	2.7	1.1	2.1	3.0	1.2	2.1	2.8	1.3
2. Poisoning	0.5	0.5	0.4	0.4	0.5	0.4	0.3	0.3	0.3	0.7	0.8	0.7
3. Falls	1.9	2.3	1.5	0.7	0.8	0.6	3.5	4.4	2.7	2.2	2.4	1.9

(Table A1.9 continued)

Condition	World			Sub-Saharan Africa			India			China		
	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female
4. Fires	0.9	0.7	1.1	1.2	1.1	1.3	2.0	1.1	2.8	0.3	0.4	0.3
5. Drowning	1.1	1.4	0.8	1.1	1.5	0.6	0.9	1.0	0.9	2.1	2.6	1.7
6. Other unintentional injuries	4.1	5.4	2.8	4.0	5.7	2.2	4.2	5.0	3.4	5.5	6.9	4.1
B. Intentional injuries	4.1	4.9	3.2	6.0	7.9	4.0	1.5	1.7	1.4	4.7	3.9	5.5
1. Self-inflicted injuries	1.4	1.4	1.3	0.2	0.2	0.1	1.0	1.0	1.0	3.9	3.0	4.9
2. Violence	1.3	1.9	0.6	2.2	3.7	0.7	0.5	0.6	0.4	0.8	0.9	0.7
3. War	1.5	1.6	1.3	3.6	4.0	3.2	0.0	0.1	0.0	0.0	0.0	0.0
4. Other intentional injuries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: Numbers in this table have been rounded, leading to rounding errors that prevent the totals for individual conditions from exactly matching the group subtotals.

(Table A1.9 continued)

Condition	Other Asia and islands			Latin American and Caribbean			Middle Eastern crescent			Formerly socialist economies		
	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female
Total DALYs (1000s)	177 671	94 900	82 771	98 285	53 718	44 567	150 849	77 592	73 257	62 200	35 664	26 536
I. Communicable, maternal, perinatal and nutritional conditions	44.7	41.8	48.0	35.3	32.6	38.7	47.7	44.5	51.1	8.8	7.2	10.9
A. Infectious and parasitic diseases	22.3	21.7	23.0	17.6	17.0	18.4	20.2	20.3	20.1	2.7	2.3	3.2
1. Tuberculosis	3.1	3.0	3.3	1.8	1.8	1.9	1.7	2.1	1.3	0.6	0.9	0.2
2. STDs excluding HIV	2.3	1.5	3.2	1.2	0.6	2.0	0.5	0.4	0.7	0.6	0.1	1.2
3. HIV	0.1	0.1	0.1	1.1	1.6	0.5	0.0	0.1	0.0	0.1	0.1	0.1
4. Diarrhoeal diseases	7.7	8.1	7.2	5.5	5.6	5.3	9.8	9.7	9.9	0.4	0.3	0.4
5. Childhood-cluster diseases	4.5	4.4	4.7	3.4	3.3	3.6	5.7	5.7	5.7	0.1	0.1	0.1
6. Bacterial meningitis and meningococcaemia	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.4	0.4	0.4
7. Malaria	1.4	1.4	1.4	0.5	0.4	0.5	0.3	0.2	0.3	0.0	0.0	0.0
8. Tropical cluster diseases and leprosy	0.4	0.5	0.3	0.8	0.8	0.9	0.2	0.2	0.2	0.0	0.0	0.0
9. Intestinal nematode infections	0.9	0.8	0.9	0.7	0.6	0.7	0.1	0.1	0.1	0.0	0.0	0.0
10. Other infectious and parasitic diseases	1.5	1.4	1.5	2.1	1.8	2.4	1.4	1.3	1.5	0.6	0.4	0.8
B. Respiratory infections	8.7	9.1	8.3	4.9	4.8	5.1	10.7	10.5	10.9	2.0	2.0	2.1
1. Lower respiratory infections	8.5	8.9	8.0	4.7	4.6	4.9	10.4	10.2	10.6	1.9	1.9	2.0
2. Other respiratory infections	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.1	0.1	0.1
C. Maternal conditions	2.3	0.0	4.9	1.7	0.0	3.8	2.4	0.0	5.0	0.9	0.0	2.1
1. Obstructed labour	0.5	0.0	1.1	0.4	0.0	0.9	0.7	0.0	1.4	0.2	0.0	0.6
2. Abortion	0.4	0.0	0.9	0.5	0.0	1.0	0.2	0.0	0.5	0.3	0.0	0.6
3. Other maternal conditions	1.3	0.0	2.8	0.9	0.0	1.9	1.5	0.0	3.1	0.4	0.0	1.0
D. Perinatal conditions	6.9	7.1	6.7	7.4	7.8	6.9	9.7	9.6	9.9	2.2	2.3	2.1
E. Nutritional deficiencies	4.4	3.8	5.2	3.7	3.0	4.5	4.7	4.1	5.3	1.0	0.7	1.4
1. Protein-energy malnutrition	1.7	1.6	1.7	1.7	1.7	1.7	2.4	2.4	2.4	0.2	0.2	0.2
2. Vitamin A deficiency and iodine deficiency	0.5	0.4	0.5	0.3	0.3	0.3	0.7	0.6	0.7	0.0	0.0	0.0
3. Iron-deficiency anaemia	2.3	1.8	3.0	1.7	1.0	2.4	1.6	1.1	2.1	0.7	0.4	1.0
4. Other nutritional deficiencies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2
II. Noncommunicable diseases	40.9	40.1	41.9	48.2	45.3	51.8	39.3	39.1	39.5	72.6	67.7	79.1
A. Malignant neoplasms	5.1	5.1	5.1	4.5	3.7	5.4	2.4	2.4	2.3	11.7	12.0	11.2
1. Stomach cancer	0.4	0.5	0.3	0.4	0.4	0.3	0.2	0.2	0.1	1.6	1.8	1.4
2. Colon and rectal cancers	0.3	0.2	0.3	0.2	0.2	0.3	0.1	0.1	0.1	1.1	0.9	1.3
3. Liver cancer	0.5	0.7	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.3	0.3
4. Tracheal, bronchial and lung cancers	0.5	0.7	0.3	0.3	0.5	0.2	0.2	0.4	0.1	2.6	3.8	0.9
5. Breast cancer	0.3	0.0	0.5	0.4	0.0	1.0	0.1	0.0	0.3	0.8	0.0	1.9
6. Cervix uteri cancer	0.3	0.0	0.6	0.4	0.0	0.8	0.1	0.0	0.2	0.3	0.0	0.7
7. Lymphomas and multiple myelomas	0.2	0.3	0.2	0.3	0.3	0.3	0.1	0.2	0.1	0.4	0.4	0.4

(Table A1.9 continued)

Condition	Other Asia and islands			Latin American and Caribbean			Middle Eastern crescent			Formerly socialist economies		
	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female
8. Leukaemia	0.5	0.5	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.5	0.5	0.5
9. Other malignant neoplasms	2.2	2.2	2.2	2.0	1.9	2.2	1.2	1.3	1.1	4.1	4.2	3.8
B. Diabetes mellitus	0.7	0.6	0.8	1.5	1.2	1.8	1.0	0.9	1.0	1.1	0.8	1.4
C. Neuropsychiatric conditions	10.8	10.1	11.6	15.9	16.2	15.4	8.7	8.2	9.1	17.2	15.4	19.7
1. Unipolar major depression	3.8	2.5	5.3	4.3	2.7	6.1	3.0	2.1	4.0	5.0	3.0	7.7
2. Bipolar disorder	1.1	1.0	1.1	1.2	1.1	1.3	0.9	0.9	0.9	1.3	1.2	1.6
3. Schizophrenia	1.3	1.2	1.3	1.3	1.2	1.4	0.9	1.0	0.9	1.4	1.3	1.5
4. Alcohol use	1.1	1.9	0.2	3.9	6.5	0.7	0.2	0.3	0.0	2.8	4.3	0.8
5. Dementia and other CNS disorders	0.5	0.4	0.6	0.6	0.5	0.8	0.2	0.2	0.2	1.5	0.9	2.3
6. Drug use	0.5	0.9	0.1	1.1	1.3	0.9	0.6	1.1	0.1	0.9	1.2	0.4
7. Epilepsy	0.5	0.5	0.5	0.7	0.7	0.7	0.3	0.3	0.3	0.6	0.7	0.5
8. Other neuropsychiatric conditions	2.1	1.8	2.5	2.8	2.2	3.5	2.5	2.3	2.7	3.7	2.9	4.8
D. Glaucoma and cataracts	0.9	0.8	1.2	0.6	0.5	0.7	0.6	0.6	0.7	0.1	0.1	0.1
E. Cardiovascular diseases	10.1	10.0	10.3	7.9	7.6	8.4	11.1	11.3	10.9	23.2	22.3	24.5
1. Rheumatic heart disease	0.1	0.1	0.1	0.2	0.1	0.3	0.5	0.4	0.6	0.6	0.5	0.8
2. Ischaemic heart disease	2.2	2.2	2.2	3.0	3.0	3.0	3.5	3.8	3.2	11.4	12.0	10.6
3. Cerebrovascular disease	2.5	2.4	2.6	2.5	2.3	2.8	1.6	1.6	1.7	7.2	5.7	9.1
4. Inflammatory heart diseases	1.3	1.3	1.3	0.5	0.5	0.6	1.2	1.2	1.2	0.7	0.8	0.7
5. Other cardiovascular diseases	4.0	4.0	4.1	1.7	1.6	1.8	4.2	4.2	4.2	3.3	3.3	3.4
F. Respiratory diseases	2.7	2.9	2.6	4.0	3.8	4.3	4.2	4.2	4.2	4.8	5.1	4.3
1. Chronic obstructive pulmonary disease	0.7	0.8	0.6	1.0	1.1	1.0	0.9	0.9	0.9	1.7	2.1	1.3
2. Asthma	0.8	0.9	0.8	1.0	0.9	1.0	0.6	0.8	0.4	0.8	0.7	0.9
3. Other respiratory diseases	1.2	1.2	1.2	2.0	1.8	2.3	2.7	2.5	2.9	2.2	2.3	2.1
G. Digestive diseases	4.7	5.2	4.1	3.8	4.0	3.6	4.2	4.3	4.1	4.4	4.4	4.4
1. Cirrhosis of the liver	1.3	1.8	0.7	1.2	1.5	0.7	0.5	0.6	0.5	1.2	1.4	1.0
2. Other digestive diseases	3.4	3.4	3.4	2.6	2.4	2.9	3.7	3.8	3.6	3.2	3.0	3.5
H. Musculo-skeletal diseases	1.2	0.9	1.5	3.1	2.2	4.3	0.6	0.5	0.7	4.4	2.8	6.5
1. Rheumatoid arthritis	0.1	0.1	0.2	0.6	0.2	1.0	0.1	0.1	0.1	0.8	0.3	1.4
2. Osteoarthritis	0.9	0.8	1.1	2.1	1.8	2.6	0.4	0.3	0.5	3.2	2.3	4.3
3. Other musculo-skeletal diseases	0.2	0.1	0.2	0.4	0.2	0.7	0.1	0.1	0.1	0.4	0.2	0.7
I. Congenital anomalies	2.3	2.3	2.4	2.7	2.4	2.9	2.7	2.7	2.8	2.2	2.0	2.3
J. Oral conditions	0.7	0.7	0.8	1.0	0.9	1.1	0.9	0.9	0.9	0.8	0.6	1.0
K. Other noncommunicable diseases	1.7	1.6	1.7	3.3	2.9	3.8	2.9	3.1	2.8	2.8	2.2	3.6

(Table A1.9 continued)

Condition	Other Asia and islands						Latin American and Caribbean				Middle Eastern crescent				Formerly socialist economies			
	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female
III. Injuries	14.4	18.2	10.1	16.4	22.2	9.5	13.0	16.3	9.4	18.7	25.1	10.0						
A. Unintentional injuries	12.1	15.4	8.3	11.9	15.6	7.5	6.8	9.2	4.3	12.9	17.8	6.3						
1. Road-traffic accidents	2.7	3.5	1.7	4.1	5.4	2.5	1.7	2.6	0.7	4.4	6.3	1.9						
2. Poisoning	0.6	0.6	0.6	0.2	0.2	0.1	0.2	0.3	0.2	1.5	2.0	0.7						
3. Falls	2.3	2.8	1.7	1.7	2.3	1.0	1.1	1.4	0.8	1.8	2.1	1.3						
4. Fires	0.3	0.3	0.3	0.3	0.3	0.3	0.5	0.4	0.5	0.3	0.4	0.2						
5. Drowning	1.6	2.0	1.0	0.9	1.3	0.4	0.6	0.8	0.4	1.0	1.4	0.3						
6. Other unintentional injuries	4.7	6.3	3.0	4.8	6.2	3.1	2.7	3.7	1.7	3.9	5.6	1.7						
B. Intentional injuries	2.3	2.7	1.8	4.5	6.6	2.1	6.2	7.1	5.1	5.8	7.3	3.8						
1. Self-inflicted injuries	1.1	1.1	1.1	0.6	0.7	0.5	0.9	1.2	0.6	2.6	3.6	1.2						
2. Violence	0.9	1.3	0.4	3.2	5.1	0.9	0.8	1.0	0.6	1.4	1.8	0.7						
3. War	0.3	0.4	0.3	0.7	0.7	0.7	4.5	5.0	3.9	1.8	1.9	1.8						
4. Other intentional injuries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						

(Table A1.9 continued)

Condition	Established market economies				EME + FSE				Demographically developing regions			
	All	Male	Female	All	Male	Female	All	Male	All	Male	Female	All
Total DALYs (1000s)	98 794	54 715	44 080	160 994	90 379	70 615	1 218 244	631 653	1 218 244	631 653	586 590	1 218 244
I. Communicable, maternal perinatal and nutritional conditions	7.1	6.7	7.7	7.8	6.9	8.9	48.7	45.6	48.7	45.6	52.1	48.7
A. Infectious and parasitic diseases	2.8	3.0	2.5	2.7	2.7	2.8	25.6	25.5	25.6	25.5	25.7	25.6
1. Tuberculosis	0.1	0.2	0.1	0.3	0.5	0.1	3.1	3.4	3.1	3.4	2.8	3.1
2. STDs excluding HIV	0.4	0.0	0.9	0.5	0.1	1.0	1.5	1.0	1.5	1.0	2.0	1.5
3. HIV	1.3	2.0	0.4	0.8	1.2	0.3	0.8	0.8	0.8	0.8	0.8	0.8
4. Diarrhoeal diseases	0.2	0.2	0.3	0.3	0.3	0.3	8.1	8.1	8.1	8.1	8.1	8.1
5. Childhood-cluster diseases	0.0	0.0	0.0	0.0	0.0	0.1	5.8	5.8	5.8	5.8	5.9	5.8
6. Bacterial meningitis and meningococcaemia	0.2	0.2	0.2	0.3	0.3	0.3	0.5	0.5	0.5	0.5	0.5	0.5
7. Malaria	0.0	0.0	0.0	0.0	0.0	0.0	2.6	2.7	2.6	2.7	2.5	2.6
8. Tropical cluster diseases and leprosy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9. Intestinal nematode infections	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.4	0.4	0.4	0.4
10. Other infectious and parasitic diseases	0.5	0.4	0.7	0.5	0.4	0.7	2.7	2.9	2.7	2.9	2.6	2.7
B. Respiratory infections	1.4	1.3	1.4	1.6	1.6	1.7	9.4	9.2	9.4	9.2	9.6	9.4
1. Lower respiratory infections	1.2	1.2	1.3	1.5	1.4	1.5	9.1	8.9	9.1	8.9	9.2	9.1
2. Other respiratory infections	0.1	0.1	0.2	0.1	0.1	0.1	0.3	0.3	0.3	0.3	0.3	0.3
C. Maternal conditions	0.3	0.0	0.7	0.6	0.0	1.3	2.4	0.0	2.4	0.0	4.9	2.4
1. Obstructed labour	0.2	0.0	0.5	0.2	0.0	0.5	0.5	0.0	0.5	0.0	1.0	0.5
2. Abortion	0.0	0.0	0.0	0.1	0.0	0.2	0.4	0.0	0.4	0.0	0.8	0.4
3. Other maternal conditions	0.1	0.0	0.2	0.2	0.0	0.5	1.5	0.0	1.5	0.0	3.1	1.5
D. Perinatal conditions	1.8	1.8	1.7	1.9	2.0	1.9	7.3	7.2	7.3	7.2	7.4	7.3
E. Nutritional deficiencies	0.9	0.5	1.3	0.9	0.6	1.3	4.1	3.7	4.1	3.7	4.5	4.1
1. Protein-energy malnutrition	0.1	0.1	0.1	0.1	0.1	0.1	1.7	1.6	1.7	1.6	1.8	1.7
2. Vitamin A deficiency and iodine deficiency	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.4	0.4	0.5	0.4
3. Iron-deficiency anaemia	0.7	0.4	1.1	0.7	0.4	1.1	1.9	1.7	1.9	1.7	2.2	1.9
4. Other nutritional deficiencies	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
II. Noncommunicable diseases	81.0	77.8	84.9	77.7	73.8	82.7	36.1	35.8	36.1	35.8	36.4	36.1
A. Malignant neoplasms	15.0	15.2	14.8	13.7	14.0	13.4	4.0	4.2	4.0	4.2	3.7	4.0
1. Stomach cancer	1.1	1.2	0.9	1.3	1.5	1.1	0.5	0.6	0.5	0.6	0.4	0.5
2. Colon and rectal cancers	1.6	1.6	1.7	1.4	1.3	1.6	0.2	0.2	0.2	0.2	0.2	0.2
3. Liver cancer	0.3	0.5	0.2	0.3	0.4	0.2	0.5	0.7	0.5	0.7	0.3	0.5
4. Tracheal, bronchial and lung cancers	3.0	4.0	1.8	2.8	3.9	1.5	0.4	0.5	0.4	0.5	0.2	0.4
5. Breast cancer	1.4	0.0	3.2	1.2	0.0	2.7	0.2	0.0	0.2	0.0	0.4	0.2
6. Cervix uteri cancer	0.2	0.0	0.4	0.2	0.0	0.5	0.2	0.0	0.2	0.0	0.4	0.2
7. Lymphomas and multiple myelomas	0.7	0.7	0.7	0.6	0.6	0.6	0.2	0.2	0.2	0.2	0.1	0.2

(Table A1.9 continued)

Condition	Established market economies			EME + FSE			Demographically developing regions		
	All	Male	Female	All	Male	Female	All	Male	Female
8. Leukaemia	0.6	0.6	0.6	0.6	0.6	0.5	0.3	0.3	0.3
9. Other malignant neoplasms	6.0	6.6	5.3	5.3	5.7	4.7	1.6	1.7	1.5
B. Diabetes mellitus	2.4	2.0	2.9	1.9	1.5	2.3	0.7	0.6	0.7
C. Neuropsychiatric conditions	25.0	23.6	26.9	22.0	20.3	24.2	9.0	8.5	9.5
1. Unipolar major depression	6.8	4.3	9.9	6.1	3.7	9.1	3.4	2.3	4.5
2. Bipolar disorder	1.7	1.6	1.9	1.6	1.4	1.8	1.0	0.9	1.0
3. Schizophrenia	2.3	2.1	2.4	1.9	1.8	2.1	0.8	0.8	0.8
4. Alcohol use	4.7	7.2	1.7	4.0	6.1	1.3	0.8	1.5	0.2
5. Dementia and other CNS disorders	2.9	2.1	4.0	2.4	1.6	3.3	0.4	0.3	0.4
6. Drug use	1.5	2.1	0.8	1.3	1.7	0.7	0.3	0.5	0.1
7. Epilepsy	0.5	0.5	0.5	0.5	0.6	0.5	0.4	0.4	0.4
8. Other neuropsychiatric conditions	4.6	3.7	5.7	4.2	3.4	5.3	2.0	1.7	2.2
D. Glaucoma and cataracts	0.1	0.1	0.1	0.1	0.1	0.1	0.8	0.7	1.0
E. Cardiovascular diseases	18.6	19.0	18.0	20.4	20.3	20.4	8.2	8.2	8.3
1. Rheumatic heart disease	0.2	0.1	0.2	0.3	0.3	0.4	0.5	0.4	0.6
2. Ischaemic heart disease	9.0	9.9	7.8	9.9	10.7	8.9	2.5	2.6	2.4
3. Cerebrovascular disease	5.0	4.4	5.8	5.9	4.9	7.0	2.4	2.4	2.4
4. Inflammatory heart diseases	0.7	0.8	0.6	0.7	0.8	0.6	0.8	0.7	0.8
5. Other cardiovascular diseases	3.7	3.8	3.5	3.6	3.6	3.5	2.1	2.1	2.1
F. Respiratory diseases	4.8	5.1	4.5	4.8	5.1	4.4	4.3	4.5	4.2
1. Chronic obstructive pulmonary disease	2.3	2.7	1.8	2.1	2.5	1.6	2.1	2.2	2.0
2. Asthma	1.3	1.2	1.3	1.1	1.0	1.2	0.7	0.8	0.7
3. Other respiratory diseases	1.3	1.2	1.3	1.6	1.6	1.6	1.5	1.4	1.5
G. Digestive diseases	4.4	4.5	4.2	4.4	4.5	4.3	3.3	3.7	3.0
1. Cirrhosis of the liver	1.6	2.0	1.1	1.5	1.8	1.0	0.9	1.2	0.6
2. Other digestive diseases	2.8	2.5	3.1	2.9	2.7	3.2	2.4	2.5	2.4
H. Musculo-skeletal diseases	4.2	2.5	6.2	4.3	2.6	6.3	1.0	0.7	1.3
1. Rheumatoid arthritis	0.9	0.4	1.6	0.9	0.4	1.5	0.2	0.1	0.2
2. Osteoarthritis	2.7	1.9	3.8	2.9	2.1	4.0	0.7	0.5	0.9
3. Other musculo-skeletal diseases	0.5	0.2	0.9	0.5	0.2	0.8	0.1	0.1	0.2
I. Congenital anomalies	2.2	2.1	2.3	2.2	2.1	2.3	2.4	2.3	2.5
J. Oral conditions	0.9	0.8	1.0	0.8	0.7	1.0	0.5	0.5	0.5
K. Other noncommunicable diseases	3.4	2.9	4.0	3.2	2.6	3.9	1.8	1.9	1.8

(Table A1.9 continued)

Condition	Established market economies			EME + FSE			Demographically developing regions		
	All	Male	Female	All	Male	Female	All	Male	Female
III. Injuries	11.9	15.5	7.4	14.5	19.3	8.4	15.2	18.6	11.5
A. Unintentional injuries	8.7	11.3	5.5	10.3	13.8	5.8	11.1	13.8	8.2
1. Road-traffic accidents	4.4	5.7	2.7	4.4	5.9	2.4	2.2	3.1	1.3
2. Poisoning	0.3	0.4	0.2	0.7	1.0	0.4	0.4	0.5	0.4
3. Falls	1.4	1.5	1.2	1.5	1.7	1.3	2.0	2.4	1.6
4. Fires	0.3	0.3	0.2	0.3	0.3	0.2	0.9	0.7	1.2
5. Drowning	0.3	0.4	0.1	0.5	0.8	0.2	1.2	1.5	0.9
6. Other unintentional injuries	2.2	3.0	1.1	2.8	4.0	1.3	4.3	5.6	2.9
B. Intentional injuries	3.2	4.3	1.9	4.2	5.5	2.6	4.1	4.8	3.3
1. Self-inflicted injuries	2.2	2.9	1.3	2.3	3.2	1.3	1.2	1.2	1.3
2. Violence	1.0	1.4	0.5	1.1	1.6	0.6	1.3	1.9	0.6
3. War	0.0	0.0	0.0	0.7	0.7	0.7	1.5	1.7	1.4
4. Other intentional injuries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: Numbers in this table have been rounded, leading to rounding errors that prevent the totals for individual conditions from exactly matching the group subtotals.

Table A1.10 Global burden of disease in 2020, disaggregated by region, cause and gender

Condition	DALYs by cause, as percentage of regional total											
	World				Sub-Saharan Africa				India			
	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female
Total DALYs (1000s)	1 388 836	796 144	592 692	329 566	188 386	141 179	236 741	133 164	103 577	220 667	127 595	93 072
I. Communicable, maternal, perinatal and nutritional conditions	20.1	18.7	22.0	39.8	36.5	44.1	24.4	23.5	25.5	4.3	3.8	5.1
A. Infectious and parasitic diseases	12.9	12.3	13.8	28.5	26.2	31.7	17.3	17.5	17.1	1.4	1.3	1.5
1. Tuberculosis	3.1	2.9	3.3	6.7	5.5	8.3	6.7	7.6	5.6	0.4	0.5	0.4
2. STDs excluding HIV	0.6	0.4	0.8	1.0	0.8	1.4	0.7	0.5	1.1	0.0	0.0	0.0
3. HIV	2.6	2.6	2.7	4.4	3.5	5.5	4.6	4.6	4.7	0.1	0.1	0.1
4. Diarrhoeal diseases	2.7	2.6	2.8	5.5	5.5	5.4	2.5	2.3	2.9	0.3	0.2	0.3
5. Childhood-cluster diseases	2.0	1.9	2.1	5.1	5.0	5.3	1.5	1.4	1.6	0.2	0.2	0.2
6. Bacterial meningitis and meningococcaemia	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
7. Malaria	1.1	1.1	1.1	4.5	4.5	4.4	0.1	0.1	0.1	0.0	0.0	0.0
8. Tropical cluster diseases and leprosy	0.2	0.2	0.2	0.5	0.6	0.4	0.2	0.2	0.1	0.0	0.0	0.0
9. Intestinal nematode infections	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
10. Other infectious and parasitic diseases	0.5	0.4	0.5	0.6	0.5	0.6	0.7	0.7	0.8	0.2	0.2	0.3
B. Respiratory infections	3.2	3.0	3.4	5.4	5.4	5.5	3.2	2.8	3.7	1.1	0.9	1.4
1. Lower respiratory infections	3.1	2.9	3.3	5.3	5.3	5.3	3.1	2.7	3.6	1.1	0.9	1.3
2. Other respiratory infections	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
C. Maternal conditions	0.3	0.0	0.7	0.6	0.0	1.4	0.3	0.0	0.7	0.1	0.0	0.1
1. Obstructed labour	0.1	0.0	0.2	0.1	0.0	0.2	0.1	0.0	0.1	0.0	0.0	0.0
2. Abortion	0.1	0.0	0.1	0.1	0.0	0.2	0.1	0.0	0.1	0.0	0.0	0.0
3. Other maternal conditions	0.2	0.0	0.5	0.4	0.0	0.9	0.2	0.0	0.4	0.0	0.0	0.1
D. Perinatal conditions	2.5	2.3	2.7	3.7	3.4	3.9	2.4	2.2	2.7	0.9	0.8	1.0
E. Nutritional deficiencies	1.2	1.1	1.4	1.5	1.4	1.7	1.2	1.0	1.4	0.9	0.8	1.0
1. Protein-energy malnutrition	0.6	0.5	0.6	1.0	0.9	1.0	0.4	0.4	0.5	0.2	0.1	0.2
2. Vitamin A deficiency and iodine deficiency	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
3. Iron-deficiency anaemia	0.5	0.4	0.7	0.4	0.3	0.4	0.6	0.5	0.8	0.7	0.6	0.8
4. Other nutritional deficiencies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
II. Noncommunicable diseases	59.7	58.2	61.8	31.9	28.9	35.9	56.5	56.2	56.8	79.3	80.5	77.6
A. Malignant neoplasms	9.9	10.8	8.7	4.5	4.5	4.4	7.1	7.2	7.0	18.7	22.7	13.3
1. Stomach cancer	1.2	1.4	0.8	0.3	0.3	0.3	0.5	0.6	0.4	3.7	4.5	2.4
2. Colon and rectal cancers	0.6	0.6	0.6	0.1	0.1	0.1	0.2	0.2	0.2	1.0	1.0	0.9
3. Liver cancer	1.1	1.5	0.5	0.7	0.9	0.3	0.1	0.2	0.1	4.2	5.8	1.9
4. Tracheal, bronchial and lung cancers	1.8	2.5	1.0	0.2	0.2	0.2	1.5	2.3	0.5	3.4	4.6	1.8
5. Breast cancer	0.4	0.0	1.0	0.2	0.0	0.4	0.4	0.0	1.0	0.3	0.0	0.7

(Table A1.10 continued)

Condition	World			Sub-Saharan Africa			India			China		
	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female
6. Cervix uteri cancer	0.4	0.0	0.9	0.3	0.0	0.7	0.6	0.0	1.4	0.2	0.0	0.6
7. Lymphomas and multiple myelomas	0.4	0.4	0.3	0.4	0.4	0.3	0.2	0.3	0.2	0.3	0.3	0.2
8. Leukaemia	0.4	0.4	0.4	0.1	0.1	0.2	0.2	0.3	0.2	0.9	0.9	0.9
9. Other malignant neoplasms	3.7	4.0	3.2	2.2	2.4	2.0	3.3	3.4	3.1	4.8	5.5	3.8
B. Diabetes mellitus	0.8	0.6	1.0	0.2	0.1	0.2	0.8	0.7	1.0	0.4	0.4	0.6
C. Neuropsychiatric conditions	14.7	12.4	17.7	8.5	7.1	10.3	12.6	10.0	15.9	15.4	11.8	20.4
1. Unipolar major depression	5.7	3.5	8.6	3.5	2.1	5.4	5.6	3.6	8.3	7.3	4.5	11.2
2. Bipolar disorder	1.5	1.3	1.8	1.0	0.9	1.2	1.5	1.4	1.7	1.9	1.7	2.2
3. Schizophrenia	1.2	1.1	1.4	0.3	0.3	0.4	1.1	1.0	1.2	1.2	1.1	1.3
4. Alcohol use	1.7	2.5	0.5	1.3	1.9	0.6	0.6	0.9	0.1	0.8	1.2	0.1
5. Dementia and other CNS disorders	1.1	0.8	1.5	0.2	0.1	0.4	0.7	0.6	0.9	1.3	1.0	1.7
6. Drug use	0.6	0.8	0.2	0.3	0.4	0.1	0.0	0.1	0.0	0.1	0.1	0.0
7. Epilepsy	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.2
8. Other neuropsychiatric conditions	2.7	2.1	3.5	1.6	1.2	2.1	2.7	2.1	3.5	2.7	2.0	3.7
D. Glaucoma and cataracts	1.6	1.4	1.9	1.3	1.1	1.6	2.7	2.6	2.7	1.7	1.3	2.4
E. Cardiovascular diseases	14.7	16.1	12.9	6.0	5.5	6.6	18.4	20.9	15.2	16.3	19.1	12.6
1. Rheumatic heart disease	0.5	0.5	0.5	0.2	0.2	0.2	0.8	0.8	0.8	1.1	1.2	1.1
2. Ischaemic heart disease	5.9	6.7	4.9	1.5	1.3	1.6	9.3	10.8	7.4	4.7	5.5	3.6
3. Cerebrovascular disease	4.4	4.6	4.1	2.6	2.2	3.1	3.4	3.6	3.0	8.2	9.7	6.2
4. Inflammatory heart diseases	0.8	0.9	0.7	0.6	0.6	0.7	1.0	1.1	0.8	0.6	0.7	0.4
5. Other cardiovascular diseases	3.1	3.4	2.6	1.1	1.1	1.1	4.0	4.6	3.2	1.6	2.0	1.2
F. Respiratory diseases	7.3	7.0	7.7	4.5	4.1	5.1	6.4	6.4	6.4	16.3	16.2	16.5
1. Chronic obstructive pulmonary disease	4.1	4.1	4.1	1.4	1.4	1.5	2.8	3.1	2.5	14.5	14.3	14.7
2. Asthma	1.0	0.9	1.0	0.7	0.6	0.8	0.9	0.9	0.8	1.2	1.2	1.2
3. Other respiratory diseases	2.2	2.0	2.5	2.4	2.1	2.8	2.7	2.5	3.0	0.6	0.7	0.6
G. Digestive diseases	3.5	3.9	3.1	1.8	2.0	1.6	2.5	3.1	1.7	3.5	3.7	3.3
1. Cirrhosis of the liver	1.2	1.5	0.7	0.3	0.4	0.2	1.3	1.7	0.7	1.4	1.7	1.0
2. Other digestive diseases	2.3	2.3	2.4	1.5	1.6	1.5	1.2	1.4	1.0	2.1	2.0	2.2
H. Musculo-skeletal diseases	2.2	1.5	3.3	0.8	0.5	1.2	1.1	0.8	1.6	2.6	1.5	4.2
1. Rheumatoid arthritis	0.4	0.2	0.6	0.1	0.0	0.1	0.1	0.1	0.2	0.5	0.3	0.9
2. Osteoarthritis	1.7	1.2	2.5	0.7	0.4	1.1	1.0	0.7	1.4	1.9	1.1	2.9
3. Other musculo-skeletal diseases	0.1	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.4
I. Congenital anomalies	2.2	1.9	2.6	2.2	1.9	2.7	3.2	2.8	3.7	1.9	1.6	2.3
J. Oral conditions	0.9	0.8	1.1	0.3	0.2	0.3	0.8	0.7	0.9	0.7	0.6	0.9
K. Other noncommunicable diseases	1.9	1.9	1.9	1.9	1.9	1.8	0.9	1.1	0.7	1.6	1.8	1.4

(Table A1.10 continued)

Condition	World			Sub-Saharan Africa			India			China		
	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female
III. Injuries	20.1	23.1	16.2	28.3	34.6	20.0	19.1	20.2	17.7	16.4	15.7	17.3
A. Unintentional injuries	13.0	15.1	10.3	15.4	18.9	10.7	16.4	17.5	14.9	11.0	11.6	10.2
1. Road-traffic accidents	5.1	6.2	3.6	5.1	6.3	3.5	6.5	8.2	4.3	4.8	5.4	4.0
2. Poisoning	0.5	0.5	0.5	0.6	0.6	0.6	0.4	0.3	0.5	0.5	0.5	0.5
3. Falls	1.5	1.6	1.5	0.9	0.9	0.9	2.6	2.7	2.5	1.4	1.2	1.7
4. Fires	0.8	0.6	1.1	1.5	1.4	1.8	1.9	1.0	3.0	0.2	0.2	0.2
5. Drowning	0.9	1.1	0.7	1.2	1.6	0.8	0.8	0.8	0.8	1.0	1.0	0.9
6. Other unintentional injuries	4.2	5.1	2.9	5.9	8.0	3.2	4.2	4.6	3.8	3.1	3.4	2.8
B. Intentional injuries	7.1	8.0	5.9	12.9	15.7	9.2	2.8	2.7	2.8	5.4	4.1	7.1
1. Self-inflicted injuries	1.9	1.8	2.0	0.4	0.5	0.2	1.8	1.6	2.0	4.5	3.2	6.4
2. Violence	2.3	3.2	1.0	4.9	7.5	1.6	0.9	1.0	0.8	0.8	0.8	0.8
3. War	3.0	3.0	2.9	7.6	7.7	7.5	0.1	0.1	0.0	0.0	0.0	0.0
4. Other intentional injuries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: Numbers in this table have been rounded, leading to rounding errors that prevent the totals for individual conditions from exactly matching the group subtotals.

(Table A1.10 continued)

Condition	Other Asia and islands			Latin America and Caribbean			Middle Eastern crescent			Formerly socialist economies		
	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female
Total DALYs ('000s)	165 978	94 706	71 272	107 639	61 870	45 769	167 710	95 296	72 414	63 534	39 594	23 940
I. Communicable, maternal, perinatal and nutritional conditions	16.5	15.3	18.0	12.6	13.0	12.1	19.9	18.2	22.0	3.0	2.3	4.0
A. Infectious and parasitic diseases	9.7	9.2	10.4	7.4	8.2	6.3	8.4	8.0	8.8	1.0	0.7	1.3
1. Tuberculosis	1.2	1.1	1.4	0.5	0.5	0.4	0.5	0.6	0.4	0.1	0.2	0.1
2. STDs excluding HIV	0.9	0.6	1.3	0.4	0.2	0.8	0.2	0.2	0.3	0.2	0.1	0.5
3. HIV	3.0	2.9	3.0	2.9	4.0	1.5	0.2	0.3	0.1	0.2	0.2	0.3
4. Diarrhoeal diseases	2.2	2.3	2.1	1.5	1.5	1.4	4.2	3.9	4.5	0.1	0.1	0.1
5. Childhood-cluster diseases	1.2	1.2	1.3	0.9	0.9	1.0	2.4	2.2	2.5	0.0	0.0	0.0
6. Bacterial meningitis and meningococcaemia	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1
7. Malaria	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
8. Tropical cluster diseases and leprosy	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0
9. Intestinal nematode infections	0.2	0.2	0.3	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0
10. Other infectious and parasitic diseases	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.5	0.7	0.2	0.1	0.2
B. Respiratory infections	2.8	2.8	2.9	1.5	1.5	1.6	4.6	4.3	5.0	0.8	0.7	1.1
1. Lower respiratory infections	2.8	2.7	2.8	1.5	1.4	1.6	4.5	4.2	4.9	0.8	0.7	1.0
2. Other respiratory infections	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0
C. Maternal conditions	0.3	0.0	0.7	0.2	0.0	0.6	0.4	0.0	1.0	0.1	0.0	0.3
1. Obstructed labour	0.1	0.0	0.2	0.1	0.0	0.1	0.0	0.0	0.3	0.0	0.0	0.1
2. Abortion	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1
3. Other maternal conditions	0.2	0.0	0.4	0.1	0.0	0.3	0.3	0.0	0.6	0.1	0.0	0.1
D. Perinatal conditions	2.2	2.2	2.3	2.3	2.4	2.2	4.6	4.3	5.0	0.7	0.7	0.8
E. Nutritional deficiencies	1.4	1.2	1.7	1.1	0.9	1.3	1.9	1.6	2.2	0.3	0.2	0.5
1. Protein-energy malnutrition	0.5	0.5	0.5	0.5	0.5	0.5	1.0	1.0	1.1	0.1	0.0	0.1
2. Vitamin A deficiency and iodine deficiency	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.0	0.0	0.0
3. Iron-deficiency anaemia	0.8	0.6	1.0	0.5	0.3	0.7	0.6	0.4	0.8	0.2	0.2	0.4
4. Other nutritional deficiencies	(0.0)	0.0	(0.0)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
II. Noncommunicable diseases	66.3	64.3	68.9	68.1	62.7	75.3	59.6	58.3	61.3	79.7	76.9	84.2
A. Malignant neoplasms	11.6	12.1	11.0	8.5	7.0	10.5	5.3	5.8	4.8	16.1	18.3	12.6
1. Stomach cancer	1.0	1.2	0.7	0.8	0.9	0.7	0.4	0.5	0.3	2.4	2.8	1.6
2. Colon and rectal cancers	0.6	0.6	0.7	0.5	0.4	0.6	0.2	0.2	0.2	1.4	1.4	1.4
3. Liver cancer	1.3	1.7	0.6	0.1	0.1	0.1	0.2	0.2	0.1	0.4	0.5	0.3
4. Tracheal, bronchial and lung cancers	1.9	2.6	1.0	1.3	1.3	1.2	1.2	1.9	0.5	4.4	6.1	1.7
5. Breast cancer	0.5	0.0	1.2	0.8	0.0	1.8	0.3	0.0	0.6	0.8	0.0	2.0
6. Cervix uteri cancer	0.6	0.0	1.4	0.7	0.0	1.5	0.2	0.0	0.4	0.3	0.0	0.7

(Table A1.10 continued)

Condition	Other Asia and islands			Latin America and Caribbean			Middle Eastern crescent			Formerly socialist economies		
	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female
7. Lymphomas and multiple myelomas	0.4	0.5	0.4	0.4	0.4	0.4	0.2	0.3	0.2	0.5	0.5	0.4
8. Leukaemia	0.6	0.6	0.6	0.4	0.4	0.4	0.4	0.3	0.4	0.5	0.5	0.5
9. Other malignant neoplasms	4.7	4.9	4.5	3.6	3.5	3.8	2.3	2.4	2.1	5.5	6.3	4.0
B. Diabetes mellitus	0.9	0.7	1.1	1.6	1.2	2.0	1.0	0.9	1.1	0.7	0.5	1.1
C. Neuropsychiatric conditions	17.4	15.0	20.5	21.6	21.1	22.2	14.9	12.4	18.1	16.4	13.2	21.7
1. Unipolar major depression	6.6	4.0	10.0	6.4	3.9	9.8	6.0	3.7	8.9	5.0	2.7	8.9
2. Bipolar disorder	1.8	1.6	2.1	1.7	1.5	2.0	1.7	1.5	1.9	1.3	1.0	1.8
3. Schizophrenia	2.0	1.9	2.3	1.8	1.6	2.0	1.8	1.6	1.9	1.3	1.1	1.7
4. Alcohol use	1.8	2.9	0.3	5.6	8.9	1.0	0.3	0.5	0.1	2.7	3.9	0.9
5. Dementia and other CNS disorders	1.1	0.8	1.5	1.2	0.9	1.7	0.4	0.3	0.4	1.9	1.0	3.3
6. Drug use	0.8	1.3	0.2	1.5	1.7	1.2	1.1	1.8	0.3	0.8	1.1	0.4
7. Epilepsy	0.3	0.4	0.3	0.4	0.5	0.4	0.3	0.3	0.3	0.3	0.3	0.3
8. Other neuropsychiatric conditions	2.9	2.2	3.8	2.9	2.2	4.0	3.4	2.8	4.2	3.0	2.1	4.5
D. Glaucoma and cataracts	2.3	1.8	2.9	1.2	1.0	1.4	1.3	1.2	1.5	0.1	0.1	0.2
E. Cardiovascular diseases	15.6	16.6	14.3	13.2	13.7	12.4	17.7	19.4	15.5	26.1	26.9	24.7
1. Rheumatic heart disease	0.1	0.1	0.1	0.2	0.1	0.3	0.4	0.4	0.5	0.5	0.5	0.5
2. Ischaemic heart disease	5.1	5.4	4.6	5.6	6.0	5.0	7.5	8.5	6.2	13.3	14.7	11.0
3. Cerebrovascular disease	4.5	4.6	4.4	4.3	4.3	4.3	2.8	2.9	2.8	7.7	6.9	8.9
4. Inflammatory heart diseases	1.2	1.3	1.0	0.6	0.6	0.6	1.4	1.5	1.2	0.7	0.8	0.6
5. Other cardiovascular diseases	4.7	5.1	4.1	2.5	2.6	2.4	5.6	6.1	4.9	3.8	3.9	3.6
F. Respiratory diseases	4.3	4.1	4.4	6.3	4.7	8.5	6.6	6.3	6.9	8.1	8.4	7.5
1. Chronic obstructive pulmonary disease	1.7	1.8	1.7	2.5	2.0	3.2	2.2	2.1	2.4	3.3	3.7	2.5
2. Asthma	1.1	1.0	1.1	1.3	1.0	1.7	0.9	1.0	0.7	0.9	0.8	1.2
3. Other respiratory diseases	1.5	1.4	1.6	2.5	1.8	3.5	3.4	3.2	3.8	3.9	3.9	3.8
G. Digestive diseases	6.5	7.2	5.4	4.6	5.1	4.1	3.7	3.8	3.4	3.9	3.8	4.1
1. Cirrhosis of the liver	2.2	3.0	1.2	1.7	2.3	0.9	0.7	0.8	0.6	1.2	1.4	0.9
2. Other digestive diseases	4.3	4.3	4.3	2.9	2.8	3.2	3.0	3.0	2.8	2.7	2.4	3.2
H. Musculo-skeletal diseases	2.6	1.9	3.4	5.5	3.7	7.8	1.2	0.9	1.5	4.5	2.6	7.5
1. Rheumatoid arthritis	0.3	0.1	0.4	1.0	0.4	1.8	0.2	0.2	0.2	0.8	0.3	1.7
2. Osteoarthritis	2.2	1.7	2.8	4.2	3.3	5.6	0.9	0.6	1.2	3.4	2.2	5.4
3. Other musculo-skeletal diseases	0.2	0.1	0.2	0.3	0.1	0.5	0.1	0.1	0.1	0.2	0.1	0.4
I. Congenital anomalies	1.8	1.7	2.0	1.7	1.4	2.0	3.3	2.9	3.7	1.2	1.0	1.4
J. Oral conditions	1.5	1.3	1.9	1.3	1.1	1.5	1.8	1.5	2.1	0.8	0.6	1.2
K. Other noncommunicable diseases	1.8	1.8	1.8	2.8	2.6	2.9	2.9	3.1	2.7	1.7	1.4	2.2

(Table A1.10 continued)

Condition	Established market economies				EME + FSE				Demographically developing regions			
	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female
	97 000	55 532	41 468	160 534	95 126	65 408	1 228 302	701 018	527 284			
Total DALYs (1000s)	5.2	5.9	4.3	4.3	4.4	4.2	22.2	20.7	24.2			
I. Communicable, maternal, perinatal and nutritional conditions												
A. Infectious and parasitic diseases	2.9	3.9	1.6	2.1	2.6	1.5	14.3	13.6	15.3			
1. Tuberculosis	0.1	0.1	0.0	0.1	0.1	0.0	3.4	3.3	3.7			
2. STDs excluding HIV	0.2	0.0	0.4	0.2	0.0	0.4	0.6	0.4	0.9			
3. HIV	2.3	3.4	0.8	1.5	2.1	0.6	2.8	2.6	3.0			
4. Diarrhoeal diseases	0.1	0.1	0.1	0.1	0.1	0.1	3.0	2.9	3.1			
5. Childhood-cluster diseases	0.0	0.0	0.0	0.0	0.0	0.0	2.3	2.2	2.4			
6. Bacterial meningitis and meningococcaemia	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2			
7. Malaria	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.3	1.3			
8. Tropical cluster diseases and leprosy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
9. Intestinal nematode infections	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1			
10. Other infectious and parasitic diseases	0.2	0.2	0.3	0.2	0.2	0.3	0.7	0.7	0.8			
B. Respiratory infections	1.2	1.1	1.3	1.0	0.9	1.2	3.4	3.3	3.6			
1. Lower respiratory infections	1.1	1.0	1.2	1.0	0.9	1.1	3.3	3.2	3.6			
2. Other respiratory infections	0.1	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1			
C. Maternal conditions	0.0	0.0	0.1	0.1	0.0	0.2	0.3	0.0	0.8			
1. Obstructed labour	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.2			
2. Abortion	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1			
3. Other maternal conditions	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.5			
D. Perinatal conditions	0.7	0.7	0.7	0.7	0.7	0.7	2.7	2.6	3.0			
E. Nutritional deficiencies	0.4	0.3	0.6	0.4	0.2	0.5	1.3	1.2	1.5			
1. Protein-energy malnutrition	0.0	0.0	0.1	0.0	0.0	0.1	0.6	0.6	0.7			
2. Vitamin A deficiency and iodine deficiency	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1			
3. Iron-deficiency anaemia	0.3	0.2	0.5	0.3	0.2	0.5	0.6	0.5	0.7			
4. Other nutritional deficiencies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
II. Noncommunicable diseases	84.7	82.2	88.0	82.7	80.0	86.6	56.7	55.3	58.7			
A. Malignant neoplasms	17.3	18.3	15.9	16.8	18.3	14.7	9.0	9.8	8.0			
1. Stomach cancer	1.2	1.4	0.9	1.1	2.0	1.2	1.1	1.3	0.8			
2. Colon and rectal cancers	1.9	1.9	1.8	1.7	1.7	1.7	0.4	0.4	0.4			
3. Liver cancer	0.4	0.5	0.2	0.4	0.5	0.2	1.2	1.6	0.6			
4. Tracheal, bronchial and lung cancers	4.6	5.6	3.3	4.5	5.8	2.7	1.5	2.1	0.8			
5. Breast cancer	1.3	0.0	3.0	1.1	0.0	2.6	0.4	0.0	0.8			
6. Cervix uteri cancer	0.2	0.0	0.4	0.2	0.0	0.5	0.4	0.0	0.9			

(Table A1.10 continued)

Condition	Established market economies			EME + FSE			Demographically developing regions		
	All	Male	Female	All	Male	Female	All	Male	Female
7. Lymphomas and multiple myelomas	0.7	0.8	0.6	0.6	0.7	0.5	0.3	0.4	0.3
8. Leukaemia	0.6	0.6	0.5	0.5	0.6	0.5	0.4	0.4	0.4
9. Other malignant neoplasms	6.5	7.5	5.2	6.1	7.0	4.8	3.3	3.6	3.0
B. Diabetes mellitus	2.1	1.7	2.6	1.5	1.2	2.1	0.7	0.6	0.8
C. Neuropsychiatric conditions	25.4	22.6	29.1	21.8	18.7	26.4	13.7	11.5	16.7
1. Unipolar major depression	6.8	4.2	10.4	6.1	3.6	9.8	5.6	3.5	8.5
2. Bipolar disorder	1.6	1.4	1.9	1.5	1.3	1.9	1.5	1.4	1.8
3. Schizophrenia	2.0	1.9	2.3	1.8	1.5	2.1	1.2	1.1	1.3
4. Alcohol use	4.5	6.6	1.6	3.8	5.5	1.3	1.4	2.2	0.3
5. Dementia and other CNS disorders	4.5	3.0	6.3	3.4	2.2	5.2	0.7	0.6	1.0
6. Drug use	1.4	1.8	0.8	1.2	1.5	0.7	0.5	0.7	0.2
7. Epilepsy	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2
8. Other neuropsychiatric conditions	4.2	3.3	5.5	3.7	2.8	5.1	2.6	2.0	3.4
D. Glaucoma and cataracts	0.1	0.1	0.2	0.1	0.1	0.2	1.8	1.5	2.1
E. Cardiovascular diseases	19.4	21.8	16.2	22.0	23.9	19.3	13.8	15.0	12.1
1. Rheumatic heart disease	0.1	0.1	0.2	0.3	0.3	0.3	0.5	0.5	0.5
2. Ischaemic heart disease	9.8	11.7	7.3	11.2	12.9	8.7	5.2	5.8	4.4
3. Cerebrovascular disease	5.1	5.1	5.2	6.2	5.9	6.6	4.2	4.5	3.8
4. Inflammatory heart diseases	0.6	0.7	0.4	0.6	0.8	0.5	0.9	0.9	0.8
5. Other cardiovascular diseases	3.7	4.2	3.0	3.7	4.1	3.3	3.0	3.3	2.6
F. Respiratory diseases	5.3	5.1	5.7	6.4	6.5	6.4	7.4	7.1	7.8
1. Chronic obstructive pulmonary disease	2.9	3.0	2.8	3.1	3.3	2.7	4.3	4.3	4.3
2. Asthma	1.1	0.9	1.3	1.0	0.8	1.3	0.9	0.9	1.0
3. Other respiratory diseases	1.3	1.1	1.6	2.4	2.3	2.4	2.2	1.9	2.5
G. Digestive diseases	5.2	5.5	4.8	4.7	4.8	4.5	3.4	3.7	2.9
1. Cirrhosis of the liver	1.9	2.5	1.2	1.6	2.0	1.1	1.1	1.5	0.7
2. Other digestive diseases	3.2	3.0	3.6	3.0	2.8	3.4	2.3	2.3	2.2
H. Musculo-skeletal diseases	5.0	3.0	7.8	4.8	2.8	7.7	1.9	1.3	2.7
1. Rheumatoid arthritis	1.2	0.5	2.0	1.0	0.4	1.9	0.3	0.2	0.5
2. Osteoarthritis	3.5	2.3	5.1	3.5	2.3	5.2	1.5	1.0	2.1
3. Other musculo-skeletal diseases	0.4	0.2	0.6	0.3	0.1	0.5	0.1	0.1	0.2
I. Congenital anomalies	0.9	0.9	1.0	1.0	0.9	1.2	2.4	2.1	2.8
J. Oral conditions	1.0	0.9	1.3	0.9	0.7	1.2	0.9	0.8	1.1
K. Other noncommunicable diseases	2.9	2.5	3.3	2.4	2.1	2.9	1.8	1.9	1.7

(Table A1.10 continued)

Condition	Established market economies			EME + FSE			Demographically developing regions		
	All	Male	Female	All	Male	Female	All	Male	Female
	10.1	11.9	7.8	13.0	15.6	9.3	21.1	24.1	17.0
III. Injuries									
A. Unintentional injuries	6.9	7.7	5.8	8.8	10.4	6.4	13.6	15.7	10.7
1. Road-traffic accidents	3.6	4.1	3.0	4.3	5.1	3.1	5.2	6.4	3.7
2. Poisoning	0.2	0.2	0.2	0.6	0.7	0.4	0.5	0.4	0.5
3. Falls	1.1	1.0	1.3	1.2	1.2	1.3	1.6	1.6	1.5
4. Fires	0.2	0.2	0.2	0.2	0.2	0.2	0.9	0.7	1.2
5. Drowning	0.2	0.2	0.1	0.4	0.5	0.2	1.0	1.1	0.7
6. Other unintentional injuries	1.6	1.9	1.1	2.1	2.7	1.3	4.4	5.4	3.1
B. Intentional injuries	3.2	4.2	2.0	4.2	5.2	2.8	7.5	8.3	6.3
1. Self-inflicted injuries	2.3	2.9	1.5	2.4	3.1	1.4	1.8	1.6	2.0
2. Violence	1.0	1.3	0.5	1.1	1.4	0.7	2.4	3.4	1.1
3. War	0.0	0.0	0.0	0.7	0.7	0.7	3.3	3.3	3.2
4. Other intentional injuries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: Numbers in this table have been rounded, leading to rounding errors that prevent the totals for individual conditions from exactly matching the group subtotals.

Table A1.11 Deaths by cause in 1990, world, established market economies and formerly socialist economies of Europe (EME + FSE), and demographically developing countries (Dem. dev.) (1000s)

	World	EME + FSE	Dem. dev.
All Causes	50 467	10 912	39 554
I. Communicable, maternal, perinatal and nutritional conditions	17 241	667	16 573
A. Infectious and parasitic diseases	9 329	163	9 166
1. Tuberculosis	1 960	38	1 922
2. Sexually transmitted diseases excluding HIV	230	1	229
a. Syphilis	204	0	204
b. Chlamydia	16	0	16
c. Gonorrhoea	9	0	9
d. Other sexually transmitted diseases	1	1	0
3. HIV	312	42	269
4. Diarrhoeal diseases	2 946	7	2 940
5. Childhood-cluster diseases	1 985	1	1 984
a. Pertussis	347	0	347
b. Polio	27	0	27
c. Diphtheria	11	0	11
d. Measles	1 058	0	1 058
e. Tetanus	542	0	541
6. Bacterial meningitis and meningococcaemia	180	11	169
7. Hepatitis B and hepatitis C	108	5	103
8. Malaria	856	0	856
9. Tropical-cluster diseases	125	0	125
a. Trypanosomiasis	47	0	47
b. Chagas disease	19	0	19
c. Schistosomiasis	8	0	8
d. Leishmaniasis	50	0	50
e. Lymphatic filariasis	0	0	0
f. Onchocerciasis	0	0	0
g. Other tropical-cluster diseases	0	0	0
10. Leprosy	3	0	3
11. Dengue	21	0	21
12. Japanese encephalitis	5	0	5
13. Trachoma	0	0	0
14. Intestinal nematode infections	22	0	22
a. Ascariasis	11	0	11
b. Trichuriasis	7	0	7
c. Ancylostomiasis and necatoriasis	4	0	4
d. Other intestinal nematode infections	0	0	0
15. Other infectious and parasitic diseases	577	57	519
B. Respiratory infections	4 380	389	3 992
1. Lower respiratory infections	4 299	385	3 915
2. Upper respiratory infections	43	3	40
3. Otitis media	28	1	28
C. Maternal conditions	454	3	451
1. Haemorrhage	114	0	113
2. Sepsis	68	0	67
3. Hypertensive disorders of pregnancy	54	1	56
4. Obstructed labour	34	0	34
5. Abortion	61	1	60
6. Other maternal conditions	121	1	120
D. Perinatal conditions	2 443	82	2 361
1. Low birth weight	1 036	16	1 020
2. Birth asphyxia and birth trauma	770	29	742
3. Other perinatal conditions	637	38	599
E. Nutritional deficiencies	634	30	604
1. Protein-energy malnutrition	372	8	364
2. Iodine deficiency	23	0	23
3. Vitamin A deficiency	106	0	106

(Table A1.11 continued)

Disease or condition	World	EME + FSE	Dem. dev.
4. Iron-deficiency anaemia	129	19	110
5. Other nutritional deficiencies	4	4	1
II. Noncommunicable diseases	28 141	9 411	18 730
A. Malignant neoplasms	6 024	2 413	3 611
1. Mouth and oropharyngeal cancers	286	50	236
2. Oesophageal cancer	358	52	306
3. Stomach cancer	752	241	511
4. Colon and rectal cancers	472	277	195
5. Liver cancer	501	58	442
6. Pancreatic cancer	183	114	69
7. Tracheal, bronchial and lung cancers	945	523	422
8. Melanoma and other skin cancers	48	31	17
9. Breast cancer	322	174	149
10. Cervix uteri cancer	200	31	169
11. Corpus uteri cancer	64	37	26
12. Ovarian cancer	107	57	50
13. Prostate cancer	193	107	86
14. Bladder cancer	131	63	68
15. Lymphoma	214	96	118
16. Leukaemia	226	76	149
17. Other malignant neoplasms	1 023	425	598
B. Other neoplasms	106	44	62
C. Diabetes mellitus	571	176	396
D. Neuropsychiatric conditions	700	274	426
1. Unipolar major depression	0	0	0
2. Bipolar disorder	15	6	9
3. Schizophrenia	51	17	34
4. Epilepsy	68	14	54
5. Alcohol use	56	24	32
6. Dementia and other degenerative CNS disorders	203	111	92
7. Parkinson disease	58	36	22
8. Multiple sclerosis	25	10	15
9. Drug use	11	4	7
10. Post-traumatic stress disorder	0	0	0
11. Obsessive-compulsive disorders	0	0	0
12. Panic disorder	0	0	0
13. Other neuropsychiatric conditions	212	52	160
E. Sense organ diseases	20	0	19
1. Glaucoma	6	0	6
2. Cataracts	6	0	6
3. Other sense organ	7	0	7
F. Cardiovascular diseases	14 327	5 245	9 082
1. Rheumatic heart disease	340	45	295
2. Ischaemic heart disease	6 260	2 695	3 565
3. Cerebrovascular disease	4 381	1 427	2 954
4. Inflammatory heart diseases	495	105	390
5. Other cardiovascular diseases	2 852	974	1 878
G. Respiratory diseases	2 935	500	2 435
1. Chronic obstructive pulmonary disease	2 211	324	1 887
2. Asthma	137	30	107
3. Other respiratory diseases	587	146	441
H. Digestive diseases	1 851	424	1 426
1. Peptic ulcer	175	45	130
2. Cirrhosis of the liver	779	168	611
3. Appendicitis	56	2	54
4. Other digestive diseases	841	209	632

(Table A1.11 continued)

Disease or condition	World	EME + FSE	Dem. dev.
I. Genito-urinary diseases	735	167	568
1. Nephritis and nephrosis	536	100	436
2. Benign prostatic hypertrophy	32	10	22
3. Other genito-urinary diseases	167	57	109
J. Musculo-skeletal diseases	97	37	60
1. Rheumatoid arthritis	16	10	6
2. Osteoarthritis	0	0	0
3. Other musculo-skeletal diseases	81	27	54
K. Congenital anomalies	589	66	523
1. Abdominal wall defect	5	1	4
2. Anencephaly	148	3	144
3. Anorectal atresia	2	0	2
4. Cleft lip	5	1	4
5. Cleft palate	4	1	3
6. Oesophageal atresia	3	0	3
7. Renal agenesis	12	2	9
8. Down syndrome	57	4	52
9. Congenital heart anomalies	207	26	181
10. Spina bifida	59	4	55
11. Other congenital anomalies	87	24	66
L. Oral conditions	2	0	2
1. Dental caries	0	0	0
2. Periodontal disease	0	0	0
3. Edentulism	0	0	0
4. Other oral conditions	2	0	2
M. Other noncommunicable diseases	186	64	121
III. Injuries	5 084	834	4 251
A. Unintentional injuries	3 233	552	2 682
1. Road-traffic accidents	999	222	777
2. Poisoning	242	57	185
3. Falls	292	99	193
4. Fires	265	18	247
5. Drowning	504	36	467
6. Other unintentional injuries	932	119	813
B. Intentional injuries	1 851	282	1 569
1. Self-inflicted injuries	786	193	594
2. Violence	563	60	502
3. War	502	29	473
4. Other intentional injuries	0	0	0

Note: Numbers in this table have been rounded, leading to rounding errors that prevent the totals for individual conditions from exactly matching the group subtotals.

Table A1.12 Projected deaths by cause in 2020, world (1000s)

	Baseline	Optimistic	Pessimistic
All Causes	68 337	64 635	78 144
I. Communicable, maternal, perinatal and nutritional conditions	10 305	8 214	16 898
A. Infectious and parasitic diseases	6 525	4 791	10 535
1. Tuberculosis	2 296	1 317	3 275
2. Sexually transmitted diseases excluding HIV	109	99	192
a. Syphilis	105	96	179
b. Chlamydia	2	1	8
c. Gonorrhoea	1	1	4
d. Other STDs	0	0	1
3. HIV	1 250	795	1 755
4. Diarrhoeal diseases	1 212	1 093	2 204
5. Childhood-cluster diseases	791	709	1 486
a. Pertussis	142	128	262
b. Polio	9	8	17
c. Diphtheria	3	3	6
d. Measles	450	406	839
e. Tetanus	187	165	362
6. Bacterial meningitis and meningococcaemia	65	56	130
7. Hepatitis B and hepatitis C	51	45	94
8. Malaria	427	387	812
9. Tropical-cluster diseases	38	31	93
a. Trypanosomiasis	14	12	38
b. Chagas disease	11	9	23
c. Schistosomiasis	3	3	7
d. Leishmaniasis	9	7	25
e. Lymphatic filariasis	0	0	0
f. Onchocerciasis	0	0	0
10. Leprosy	1	1	3
11. Dengue	3	2	8
12. Japanese encephalitis	1	1	2
13. Trachoma	0	0	0
14. Intestinal nematode infections	5	4	11
a. Ascariasis	2	1	4
b. Trichuriasis	1	1	3
c. Ancylostomiasis and necatoriasis	2	2	4
d. Other intestinal nematode infections	0	0	0
15. Other infectious and parasitic diseases	277	249	470
B. Respiratory infections	2 506	2 291	3 977
1. Lower respiratory infections	2 472	2 261	3 921
2. Upper respiratory infections	24	22	39
3. Otitis media	9	8	18
C. Maternal conditions	72	54	253
1. Haemorrhage	17	13	62
2. Sepsis	11	8	39
3. Hypertensive disorders of pregnancy	9	7	32
4. Obstructed labour	6	4	20
5. Abortion	10	7	34
6. Other maternal conditions	19	14	66
D. Perinatal conditions	907	812	1 623
E. Nutritional deficiencies	295	266	510
1. Protein-energy malnutrition	181	164	308
2. Iodine deficiency	6	5	12
3. Vitamin A deficiency	34	30	69
4. Iron-deficiency anaemia	71	64	117
5. Other nutritional deficiencies	3	3	4

(Table A1.12 continued)

	Baseline	Optimistic	Pessimistic
II. Noncommunicable diseases	49 652	48 023	53 039
A. Malignant neoplasms	12 275	12 231	12 504
1. Mouth and oropharyngeal cancers	635	642	630
2. Oesophageal cancer	823	819	831
3. Stomach cancer	1 588	1 570	1 624
4. Colon and rectal cancers	832	821	872
5. Liver cancer	1 174	1 149	1 204
6. Pancreatic cancer	318	313	334
7. Tracheal, bronchial and lung cancers	2 415	2 452	2 345
8. Melanoma and other skin cancers	79	78	82
9. Breast cancer	498	493	543
10. Cervix uteri cancer	394	399	413
11. Corpus uteri cancer	101	100	110
12. Ovarian cancer	162	161	176
13. Prostate cancer	393	396	388
14. Bladder cancer	262	262	264
15. Lymphoma	377	374	389
16. Leukaemia	346	337	365
17. Other malignant neoplasms	1 878	1 866	1 935
B. Other neoplasms	113	99	145
C. Diabetes mellitus	753	668	940
D. Neuropsychiatric conditions	824	741	998
1. Unipolar major depression	0	0	0
2. Bipolar disorder	22	20	25
3. Schizophrenia	63	56	78
4. Epilepsy	58	52	79
5. Alcohol use	55	48	75
6. Dementia and other degenerative CNS disorders	298	267	337
7. Parkinson disease	88	79	99
8. Multiple sclerosis	25	22	34
9. Drug use	8	7	11
10. Post-traumatic stress disorder	0	0	0
11. Obsessive-compulsive disorders	0	0	0
12. Panic disorder	0	0	0
13. Other neuropsychiatric conditions	207	191	258
E. Sense organ diseases	21	18	29
1. Glaucoma	7	6	10
2. Cataracts	6	5	9
3. Other sense organ diseases	7	6	10
F. Cardiovascular diseases	24 813	24 897	26 816
1. Rheumatic heart disease	471	451	561
2. Ischaemic heart disease	11 107	11 208	11 891
3. Cerebrovascular disease	7 698	7 708	8 314
4. Inflammatory heart diseases	749	734	839
5. Other cardiovascular diseases	4 788	4 797	5 212
G. Respiratory diseases	6 366	5 392	6 335
1. Chronic obstructive pulmonary disease	4 726	3 946	4 744
2. Asthma	326	281	325
3. Other respiratory diseases	1 313	1 164	1 266
H. Digestive diseases	2 722	2 332	3 131
1. Peptic ulcer	288	251	319
2. Cirrhosis of the liver	1 176	995	1 353
3. Appendicitis	36	30	55
4. Other digestive diseases	1 222	1 056	1 404
I. Genito-urinary diseases	885	792	1 128
1. Nephritis and nephrosis	632	567	810

(Table A1.12 continued)

	Baseline	Optimistic	Pessimistic
2. Benign prostatic hypertrophy	38	35	49
3. Other genito-urinary diseases	215	191	268
J. Musculo-skeletal diseases	123	107	151
1. Rheumatoid arthritis	21	18	25
2. Osteoarthritis	1	1	1
3. Other musculo-skeletal diseases	101	88	125
K. Congenital anomalies	529	539	586
L. Oral conditions	1	1	2
1. Dental caries	0	0	0
2. Periodontal disease	0	0	0
3. Edentulism	0	0	0
4. Other oral conditions	1	1	2
M. Other noncommunicable diseases	227	206	273
III. Injuries	8 381	8 398	8 207
A. Unintentional injuries	5 053	5 045	4 965
1. Road-traffic accidents	2 338	2 421	1 934
2. Poisoning	293	281	321
3. Falls	439	439	462
4. Fires	354	346	389
5. Drowning	469	449	559
6. Other unintentional injuries	1 160	1 110	1 298
B. Intentional injuries	3 328	3 352	3 242
1. Self-inflicted injuries	1 229	1 242	1 200
2. Violence	1 052	1 059	1 027
3. War	1 047	1 051	1 015

Note: Numbers in this table have been rounded, leading to rounding errors that prevent the totals for individual conditions from exactly matching the group subtotals.

Table A1.13 Projected deaths by cause in 2020, established market economies and formerly socialist economies of Europe (1000s)

	Baseline	Optimistic	Pessimistic
All Causes	13 505	12 826	15 032
I. Communicable, maternal, perinatal and nutritional conditions	674	570	860
A. Infectious and parasitic diseases	183	119	257
1. Tuberculosis	23	20	33
2. Sexually transmitted diseases excluding HIV	1	1	1
a. Syphilis	0	0	0
b. Chlamydia	0	0	0
c. Gonorrhoea	0	0	0
d. Other STDs	0	0	1
3. HIV	90	36	134
4. Diarrhoeal diseases	4	4	6
5. Childhood-cluster diseases	1	1	1
a. Pertussis	0	0	0
b. Polio	0	0	0
c. Diphtheria	0	0	0
d. Measles	0	0	0
e. Tetanus	0	0	0
6. Bacterial meningitis and meningococcaemia	5	4	8
7. Hepatitis B and hepatitis C	3	3	4
8. Malaria	0	0	0
9. Tropical-cluster diseases	0	0	0
a. Trypanosomiasis	0	0	0
b. Chagas disease	0	0	0
c. Schistosomiasis	0	0	0
d. Leishmaniasis	0	0	0
e. Lymphatic filariasis	0	0	0
f. Onchocerciasis	0	0	0
10. Leprosy	0	0	0
11. Dengue	0	0	0
12. Japanese encephalitis	0	0	0
13. Trachoma	0	0	0
14. Intestinal nematode infections	0	0	0
a. Ascariasis	0	0	0
b. Trichuriasis	0	0	0
c. Ancylostomiasis and necatoriasis	0	0	0
d. Other intestinal nematode infections	0	0	0
15. Other infectious and parasitic diseases	57	52	70
B. Respiratory infections	433	399	517
1. Lower respiratory infections	429	395	512
2. Upper respiratory infections	3	3	4
3. Otitis media	0	0	0
C. Maternal conditions	0	0	1
1. Haemorrhage	0	0	0
2. Sepsis	0	0	0
3. Hypertensive disorders of pregnancy	0	0	0
4. Obstructed labour	0	0	0
5. Abortion	0	0	0
6. Other maternal conditions	0	0	0
D. Perinatal conditions	27	23	47
E. Nutritional deficiencies	31	28	37
1. Protein-energy malnutrition	9	8	11
2. Iodine deficiency	0	0	0
3. Vitamin A deficiency	0	0	0
4. Iron-deficiency anaemia	19	17	23
5. Other nutritional deficiencies	3	2	4

(Table A1.13 continued)

	Baseline	Optimistic	Pessimistic
II. Noncommunicable diseases	11 961	11 415	13 246
A. Malignant neoplasms	3 215	3 134	3 449
1. Mouth and oropharyngeal cancers	69	66	75
2. Oesophageal cancer	71	67	78
3. Stomach cancer	332	322	359
4. Colon and rectal cancers	364	352	401
5. Liver cancer	75	72	83
6. Pancreatic cancer	148	142	165
7. Tracheal, bronchial and lung cancers	804	814	778
8. Melanoma and other skin cancers	38	36	42
9. Breast cancer	183	175	213
10. Cervix uteri cancer	32	31	36
11. Corpus uteri cancer	42	40	48
12. Ovarian cancer	60	57	70
13. Prostate cancer	163	159	174
14. Bladder cancer	90	87	97
15. Lymphoma	117	112	132
16. Leukaemia	91	87	102
17. Other malignant neoplasms	537	514	598
B. Other neoplasms	50	42	58
C. Diabetes mellitus	228	194	251
D. Neuropsychiatric conditions	344	298	379
1. Unipolar major depression	0	0	0
2. Bipolar disorder	8	7	9
3. Schizophrenia	23	20	25
4. Epilepsy	11	9	13
5. Alcohol use	19	16	24
6. Dementia and other degenerative CNS disorders	163	142	172
7. Parkinson disease	55	48	59
8. Multiple sclerosis	9	7	11
9. Drug use	2	2	3
10. Post-traumatic stress disorder	0	0	0
11. Obsessive-compulsive disorders	0	0	0
12. Panic disorder	0	0	0
13. Other neuropsychiatric conditions	55	47	63
E. Sense organ diseases	0	0	0
1. Glaucoma	0	0	0
2. Cataracts	0	0	0
3. Other sense organ diseases	0	0	0
F. Cardiovascular diseases	6 271	6 196	7 205
1. Rheumatic heart disease	43	41	53
2. Ischaemic heart disease	3 259	3 220	3 728
3. Cerebrovascular disease	1 705	1 688	1 954
4. Inflammatory heart diseases	117	114	137
5. Other cardiovascular diseases	1 147	1 134	1 333
G. Respiratory diseases	873	729	848
1. Chronic obstructive pulmonary disease	551	461	536
2. Asthma	46	38	47
3. Other respiratory diseases	276	231	264
H. Digestive diseases	600	496	625
1. Peptic ulcer	69	57	71
2. Cirrhosis of the liver	221	178	230
3. Appendicitis	3	2	3
4. Other digestive diseases	308	258	321
I. Genito-urinary diseases	216	185	241
1. Nephritis and nephrosis	129	110	144

(Table A1.13 continued)

	Baseline	Optimistic	Pessimistic
2. Benign prostatic hypertrophy	13	11	15
3. Other genito-urinary diseases	75	64	82
J. Musculo-skeletal diseases	48	40	52
1. Rheumatoid arthritis	13	11	14
2. Osteoarthritis	0	0	0
3. Other musculo-skeletal diseases	34	29	38
K. Congenital anomalies	35	32	49
L. Oral conditions	0	0	1
1. Dental caries	0	0	0
2. Periodontal disease	0	0	0
3. Edentulism	0	0	0
4. Other oral conditions	0	0	1
M. Other noncommunicable diseases	80	68	89
III. Injuries	870	841	926
A. Unintentional injuries	544	513	606
1. Road-traffic accidents	221	206	239
2. Poisoning	52	47	57
3. Falls	115	114	131
4. Fires	17	16	20
5. Drowning	29	26	34
6. Other unintentional injuries	110	103	126
B. Intentional injuries	326	328	320
1. Self-inflicted injuries	234	236	229
2. Violence	63	63	62
3. War	29	29	29

Note: Numbers in this table have been rounded, leading to rounding errors that prevent the totals for individual conditions from exactly matching the group subtotals.

Table A1.14 Projected deaths by cause in 2020, demographically developing countries (1000s)

	Baseline	Optimistic	Pessimistic
All Causes	54 832	51 809	63 112
I. Communicable, maternal, perinatal and nutritional conditions	9 631	7 644	16 038
A. Infectious and parasitic diseases	6 342	4 671	10 277
1. Tuberculosis	2 273	1 298	3 242
2. Sexually transmitted diseases excluding HIV	108	98	191
a. Syphilis	105	96	179
b. Chlamydia	2	1	8
c. Gonorrhoea	1	1	4
d. Other STDs	0	0	0
3. HIV	1 160	759	1 621
4. Diarrhoeal diseases	1 208	1 089	2 198
5. Childhood-cluster diseases	790	709	1 485
a. Pertussis	142	128	262
b. Polio	9	8	16
c. Diphtheria	3	3	6
d. Measles	450	406	839
e. Tetanus	186	165	362
6. Bacterial meningitis and meningococcaemia	60	52	122
7. Hepatitis B and hepatitis C	48	42	90
8. Malaria	427	387	812
9. Tropical-cluster diseases	38	31	93
a. Trypanosomiasis	14	12	38
b. Chagas disease	11	9	23
c. Schistosomiasis	3	3	7
d. Leishmaniasis	9	7	25
e. Lymphatic filariasis	0	0	0
f. Onchocerciasis	0	0	0
10. Leprosy	1	1	3
11. Dengue	3	2	8
12. Japanese encephalitis	1	1	2
13. Trachoma	0	0	0
14. Intestinal nematode infections	5	4	11
a. Ascariasis	2	1	4
b. Trichuriasis	1	1	3
c. Ancylostomiasis and necatoriasis	2	2	4
d. Other intestinal nematode infections	0	0	0
15. Other infectious and parasitic infections	220	197	400
B. Respiratory infections	2 073	1 893	3 461
1. Lower respiratory infections	2 043	1 866	3 409
2. Upper respiratory infections	21	19	35
3. Otitis media	9	8	17
C. Maternal conditions	71	54	252
1. Haemorrhage	17	13	62
2. Sepsis	11	8	39
3. Hypertensive disorders of pregnancy	9	7	32
4. Obstructed labour	6	4	20
5. Abortion	9	7	34
6. Other maternal conditions	19	14	66
D. Perinatal conditions	880	789	1 575
E. Nutritional deficiencies	265	238	472
1. Protein-energy malnutrition	172	155	298
2. Iodine deficiency	6	5	12
3. Vitamin A deficiency	34	30	69
4. Iron-deficiency anaemia	53	47	94
5. Other nutritional deficiencies	0	0	1

(Table A1.14 continued)

	Baseline	Optimistic	Pessimistic
II. Noncommunicable diseases	37 691	36 608	39 793
A. Malignant neoplasms	9 060	9 098	9 055
1. Mouth and oropharyngeal cancers	566	576	555
2. Oesophageal cancer	753	752	753
3. Stomach cancer	1 256	1 248	1 265
4. Colon and rectal cancers	468	469	470
5. Liver cancer	1 099	1 077	1 121
6. Pancreatic cancer	170	170	170
7. Tracheal, bronchial and lung cancers	1 611	1 638	1 567
8. Melanoma and other skin cancers	41	42	40
9. Breast cancer	315	318	330
10. Cervix uteri cancer	363	369	376
11. Corpus uteri cancer	59	60	62
12. Ovarian cancer	102	103	107
13. Prostate cancer	230	237	214
14. Bladder cancer	172	174	167
15. Lymphoma	260	262	257
16. Leukaemia	255	250	263
17. Other malignant neoplasms	1 341	1 352	1 337
B. Other neoplasms	63	56	87
C. Diabetes mellitus	525	473	689
D. Neuropsychiatric conditions	481	443	620
1. Unipolar major depression	0	0	0
2. Bipolar disorder	14	13	17
3. Schizophrenia	40	36	52
4. Epilepsy	47	43	66
5. Alcohol use	37	33	51
6. Dementia and other degenerative CNS disorders	135	125	165
7. Parkinson disease	34	31	41
8. Multiple sclerosis	17	15	23
9. Drug use	6	5	8
10. Post-traumatic stress disorder	0	0	0
11. Obsessive-compulsive disorders	0	0	0
12. Panic disorder	0	0	0
13. Other neuropsychiatric conditions	152	144	196
E. Sense organ diseases	20	17	29
1. Glaucoma	7	6	10
2. Cataracts	6	5	9
3. Other sense organ diseases	7	6	10
F. Cardiovascular diseases	18 542	18 701	19 612
1. Rheumatic heart disease	428	410	509
2. Ischaemic heart disease	7 848	7 988	8 162
3. Cerebrovascular disease	5 993	6 019	6 360
4. Inflammatory heart diseases	632	621	703
5. Other cardiovascular diseases	3 641	3 663	3 879
G. Respiratory diseases	5 492	4 663	5 488
1. Chronic obstructive pulmonary disease	4 175	3 485	4 208
2. Asthma	280	244	278
3. Other respiratory diseases	1 037	934	1 002
H. Digestive diseases	2 123	1 837	2 506
1. Peptic ulcer	219	194	249
2. Cirrhosis of the liver	956	817	1 123
3. Appendicitis	33	28	52
4. Other digestive diseases	914	798	1 083
I. Genito-urinary diseases	668	608	887
1. Nephritis and nephrosis	503	457	667

(Table A1.14 continued)

	Baseline	Optimistic	Pessimistic
2. Benign prostatic hypertrophy	26	24	34
3. Other genito-urinary diseases	140	127	186
J. Musculo-skeletal diseases	75	67	99
1. Rheumatoid arthritis	8	7	11
2. Osteoarthritis	1	1	1
3. Other musculo-skeletal diseases	67	59	87
K. Congenital anomalies	494	507	537
L. Oral conditions	1	1	1
1. Dental caries	0	0	0
2. Periodontal disease	0	0	0
3. Edentulism	0	0	0
4. Other oral conditions	1	1	1
M. Other noncommunicable diseases	147	138	184
III. Injuries	7 511	7 556	7 281
A. Unintentional injuries	4 509	4 532	4 359
1. Road-traffic accidents	2 117	2 215	1 695
2. Poisoning	241	233	265
3. Falls	324	324	331
4. Fires	337	329	370
5. Drowning	440	423	525
6. Other unintentional injuries	1 050	1 007	1 172
B. Intentional injuries	3 002	3 024	2 922
1. Self-inflicted injuries	995	1 006	971
2. Violence	990	996	964
3. War	1 018	1 022	987

Note: Numbers in this table have been rounded, leading to rounding errors that prevent the totals for individual conditions from exactly matching the group subtotals.

Annex 2

Assessing the burden of disease that can be attributed to specific risk factors

Christopher J. L. Murray and Alan D. Lopez

When measuring disease burden, a number of approaches may be taken. The first, and most obvious, is to measure the burden arising from particular diseases or conditions—for example, lung cancer. A second approach is to estimate what proportion of the disease burden in a population can be attributed to a particular *risk factor*—for example, tobacco use. Assessments of the burden attributable to different risk factors can provide useful information for the design of disease prevention strategies and indicate where efforts to reduce each of these risks might pay off. They tell us, essentially, what proportion of that burden could be removed if the specific risk factor were eliminated. Some of the early documentation of the work on disease burden (Murray, Lopez & Jamison 1994) pointed to the importance of decomposing disease burden by both risk factor and by *type* of disability; the effort undertaken for the Ad Hoc Committee provides initial assessments for risk factors, summarized in this annex and appearing more fully in the companion volumes (see Murray & Lopez 1996 and forthcoming; volume 9 in the series is to be devoted wholly to risk factors). But the work on disability remains to be undertaken.

2.1 Different types of risk factors

Risk factors are an extremely broad grouping; their common feature is that individuals exposed to them are more likely to develop given conditions than unexposed individuals. They may be behavioural (such as tobacco use), environmental (such as unsafe water and poor sanitation) or physiological (such as hypertension). Here we have assessed the current disease burden attributable to each of 10 risk factors: tobacco use; alcohol use; physical inactivity; hypertension; illicit drug use; malnutrition; unsafe water and sanitation; air pollution; occupation; and sexual activity. This list is clearly not exhaustive; between them, the 10 selected risk factors account for more than 38% of the total global burden.

The strength of the evidence to suggest a causal relationship between a risk factor and its associated diseases

varies from one factor to another. In the case of tobacco and lung cancer, all the relevant criteria for demonstrating causality have been met. For others, such as air pollution, malnutrition and some occupational injuries, not all of the strict causality criteria have been met. However, the strength of association between these factors and disease is sufficiently powerful to strongly suggest a causal relationship (see Tables A2.1 and A2.2).

Clearly, the degree of control that individuals and populations have over their exposure to risk varies with the type of risk—for example, an individual has more control over his or her smoking behaviour than over the quality of outdoor air in the environment. Indeed, the physiological risk factors that we discuss (hypertension and malnutrition) are not true exposures, but are themselves partly the consequence of other true exposures such as salt intake or inadequate dietary intake. Further discussion of the differences between types of risk exposure and their impact on assessment may be found in Murray and Lopez 1996 and forthcoming volume 9.

In considering the effects of a risk factor on human health, it is important to distinguish between two types of risk: the risk to an individual, and the risk to a population, some of whom may not be exposed to the risk factor in question. For example, an individual smoker incurs a risk to his or her health through smoking. Equally, smoking will have an impact on the health status of a population which includes both smokers and non-smokers. Thus, epidemiologists can estimate the *proportion* of deaths from a given disease which, *at population level*, are to be attributed to smoking. They can also estimate the individual risk of a smoker dying from a specific cause of death, such as lung cancer or heart disease, for which smoking increases the risks.

Risk factors that are assessed in this way are considered *direct*: they affect the individual who is directly exposed to them. However, it is also possible to assess the *indirect* hazards of certain risk factors to people other than those who are directly exposed in an environment. For example, cigarette smoke causes disease in non-smokers, and alcohol causes the deaths of many road users and pedestrians who have not been drinking. In general, however, assessments of attributable risk do not include indirect exposures.

Table A2.1 Estimated disease burden in 1990 for selected risk factors, by region: deaths, years of life lost (YLLs), years lived with a disability (YLDs) and disability-adjusted life years (DALYs) (1000s)

Risk factor / region	Deaths	% of total	YLLs	% of total	YLDs	% of total	DALYs	% of total
Air pollution								
Established market economies	65	0.9	310	0.6	169	0.3	478	0.5
Former socialist economies	210	5.5	1 320	3.7	627	2.4	1 948	3.1
India	86	0.9	1 267	0.6	186	0.2	1 453	0.5
China	68	0.8	549	0.5	353	0.4	903	0.4
Other Asia and islands	39	0.7	600	0.5	74	0.1	674	0.4
Sub-Saharan Africa	23	0.3	490	0.2	43	0.1	532	0.2
Latin America and Caribbean	34	1.1	377	0.7	98	0.2	476	0.5
Middle Eastern crescent	44	1.0	711	0.7	79	0.2	790	0.5
World	568	1.1	5 625	0.6	1 630	0.3	7 254	0.5
Established market economies and former socialist economies	275	2.5	1 630	1.9	796	1.1	2 426	1.5
Demographically developing countries	293	0.7	3 995	0.5	833	0.2	4 828	0.4
Alcohol use								
Established market economies	84	1.2	2 537	5.1	7 667	15.6	10 204	10.3
Former socialist economies	53	1.4	2 063	5.7	3 130	11.9	5 193	8.3
India	113	1.2	2 723	1.4	1 974	2.3	4 697	1.6
China	114	1.3	2 118	1.8	2 737	3.0	4 856	2.3
Other Asia and islands	97	1.8	1 862	1.6	3 191	5.1	5 053	2.8
Sub-Saharan Africa	171	2.1	4 435	2.0	3 169	4.6	7 603	2.6
Latin America and Caribbean	136	4.5	3 319	5.9	6 201	14.7	9 520	9.7
Middle Eastern crescent	6	0.1	229	0.2	437	1.0	666	0.4
World	774	1.5	19 287	2.1	28 400	6.0	47 687	3.5
Established market economies and former socialist economies	137	1.3	4 601	5.4	10 797	14.3	15 398	9.6
Demographically developing countries	637	1.6	14 686	1.8	17 603	4.4	32 289	2.7
Drug use								
Established market economies	29	0.4	717	1.4	1 598	3.3	2 315	2.3
Former socialist economies	9	0.2	226	0.6	568	2.2	794	1.3
India	7	0.1	192	0.1	112	0.1	305	0.1
China	17	0.2	443	0.4	209	0.2	652	0.3
Other Asia and islands	9	0.2	250	0.2	927	1.5	1 177	0.7
Sub-Saharan Africa	8	0.1	223	0.1	382	0.6	605	0.2
Latin America and Caribbean	16	0.5	449	0.8	1 140	2.7	1 589	1.6
Middle Eastern crescent	5	0.1	134	0.1	898	2.0	1 031	0.7
World	100	0.2	2 634	0.3	5 834	1.2	8 467	0.6
Established market economies and former socialist economies	38	0.3	943	1.1	2 166	2.9	3 108	1.9
Demographically developing countries	62	0.2	1 691	0.2	3 668	0.9	5 359	0.4
Hypertension								
Established market economies	789	11.1	3 471	7.0	411	0.8	3 882	3.9
Former socialist economies	617	16.3	3 440	9.6	256	1.0	3 696	5.9
India	369	3.9	2 568	1.3	130	0.1	2 697	0.9
China	288	3.2	1 934	1.6	144	0.2	2 077	1.0
Other Asia and islands	58	1.0	440	0.4	40	0.1	480	0.3

(Table A2.1 continued)

Risk factor / region	Deaths	% of total	YLLs	% of total	YLDs	% of total	DALYs	% of total
Sub-Saharan Africa	203	2.5	1 789	0.8	128	0.2	1 917	0.6
Latin America and Caribbean	242	8.1	1 674	3.0	134	0.3	1 808	1.8
Middle Eastern crescent	351	7.7	2 351	2.2	169	0.4	2 520	1.7
World	2 918	5.8	17 665	1.9	1 411	0.3	19 076	1.4
Established market economies and former socialist economies	1 406	12.9	6 911	8.1	667	0.9	7 577	4.7
Demographically developing countries	1 512	3.8	10 754	1.3	745	0.2	11 499	0.9
Malnutrition								
Established market economies	0	0.0	0	0.0	0	0.0	0	0.0
Former socialist economies	0	0.0	0	0.0	0	0.0	0	0.0
India	1 723	18.4	58 086	29.0	6 450	7.4	64 536	22.4
China	278	3.1	9 366	8.0	1 781	2.0	11 147	5.4
Other Asia and islands	679	12.3	23 037	20.1	2 721	4.3	25 758	14.5
Sub-Saharan Africa	2 619	31.9	89 305	39.4	7 129	10.4	96 434	32.7
Latin America and Caribbean	135	4.5	4 540	8.1	520	1.2	5 059	5.2
Middle Eastern crescent	447	9.8	15 152	14.4	1 489	3.3	16 641	11.0
World	5 881	11.7	199 486	22.0	20 090	4.3	219 575	15.9
Established market economies and former socialist economies	0	0.0	0	0.0	0	0.0	0	0.0
Demographically developing countries	5 881	14.9	199 486	24.3	20 090	5.1	219 575	18.0
Occupation								
Established market economies	154	2.2	2 826	5.7	2 144	4.4	4 971	5.0
Former socialist economies	76	2.0	1 409	3.9	951	3.6	2 359	3.8
India	185	2.0	3 671	1.8	2 159	2.5	5 830	2.0
China	247	2.8	4 937	4.2	3 295	3.6	8 232	3.9
Other Asia and islands	148	2.7	3 060	2.7	1 940	3.1	5 001	2.8
Sub-Saharan Africa	112	1.4	2 323	1.0	1 537	2.2	3 860	1.3
Latin America and Caribbean	98	3.2	1 973	3.5	1 708	4.1	3 681	3.7
Middle Eastern crescent	109	2.4	2 294	2.2	1 659	3.6	3 954	2.6
World	1 129	2.2	22 493	2.5	15 394	3.3	37 887	2.7
Established market economies and former socialist economies	230	2.1	4 235	4.9	3 095	4.1	7 330	4.6
Demographically developing countries	899	2.3	18 258	2.2	12 299	3.1	30 557	2.5
Physical inactivity								
Established market economies	833	11.7	3 860	7.8	862	1.8	4 722	4.8
Former socialist Economies	266	7.0	1 482	4.1	249	0.9	1 731	2.8
India	338	3.6	2 377	1.2	447	0.5	2 824	1.0
China	229	2.6	1 383	1.2	260	0.3	1 643	0.8
Other Asia and Islands	63	1.1	464	0.4	106	0.2	570	0.3
Sub-Saharan Africa	5	0.1	38	0.0	8	0.0	46	0.0
Latin America and Caribbean	118	3.9	796	1.4	173	0.4	969	1.0
Middle Eastern Crescent	140	3.1	954	0.9	195	0.4	1 149	0.8
World	1 991	3.9	11 353	1.3	2 300	0.5	13 653	1.0
Established market economies and former socialist economies	1 099	10.1	5 343	6.2	1 110	1.5	6 453	4.0
Demographically developing countries	892	2.3	6 011	0.7	1 190	0.3	7 200	0.6

(Table A2.1 continued)

Risk factor / region	Deaths	% of total	YLLs	% of total	YLDs	% of total	DALYs	% of total
Sexual activity								
Established market economies	54	0.8	1 271	2.6	687	1.4	1 957	2.0
Former socialist economies	33	0.9	756	2.1	613	2.3	1 369	2.2
India	222	2.4	5 755	2.9	5 769	6.6	11 525	4.0
China	43	0.5	684	0.6	196	0.2	879	0.4
Other Asia and islands	134	2.4	3 838	3.3	4 047	6.4	7 885	4.4
Sub-Saharan Africa	483	5.9	12 226	5.4	6 918	10.1	19 144	6.5
Latin America and Caribbean	74	2.5	2 003	3.6	1 642	3.9	3 645	3.7
Middle Eastern crescent	52	1.1	1 070	1.0	1 228	2.7	2 298	1.5
World	1 095	2.2	27 602	3.0	21 100	4.5	48 702	3.5
Established market economies and former socialist economies	87	0.8	2 026	2.4	1 300	1.7	3 326	2.1
Demographically developing countries	1 008	2.5	25 576	3.1	19 800	5.0	45 376	3.7
Tobacco use								
Established market economies	1 063	14.9	7 967	16.0	3 640	7.4	11 607	11.7
Former socialist economies	515	13.6	5 869	16.3	1 934	7.4	7 803	12.5
India	129	1.4	1 366	0.7	353	0.4	1 719	0.6
China	820	9.2	5 752	4.9	2 326	2.6	8 078	3.9
Other Asia and islands	223	4.0	1 996	1.7	643	1.0	2 638	1.5
Sub-Saharan Africa	78	0.9	927	0.4	290	0.4	1 217	0.4
Latin America and Caribbean	99	3.3	952	1.7	388	0.9	1 340	1.4
Middle Eastern crescent	111	2.4	1 387	1.3	392	0.9	1 779	1.2
World	3 038	6.0	26 217	2.9	9 965	2.1	36 182	2.6
Established market economies and former socialist economies	1 577	14.5	13 836	16.2	5 574	7.4	19 410	12.1
Demographically developing countries	1 460	3.7	12 381	1.5	4 391	1.1	16 772	1.4
Water and sanitation								
Established market economies	1	0.0	8	0.0	92	0.2	101	0.1
Former socialist economies	2	0.1	75	0.2	53	0.2	128	0.2
India	840	9.0	25 993	13.0	1 470	1.7	27 463	9.5
China	81	0.9	1 975	1.7	2 256	2.5	4 231	2.0
Other Asia and islands	354	6.4	11 693	10.2	1 499	2.4	13 192	7.4
Sub-Saharan Africa	876	10.7	28 781	12.7	1 088	1.6	29 870	10.1
Latin America and Caribbean	135	4.5	4 254	7.6	929	2.2	5 183	5.3
Middle Eastern crescent	378	8.3	12 740	12.1	484	1.1	13 224	8.8
World	2 668	5.3	85 520	9.4	7 872	1.7	93 392	6.8
Established market economies and former socialist economies	3	0.0	83	0.1	146	0.2	229	0.1
Demographically developing countries	2 665	6.7	85 436	10.4	7 726	1.9	93 163	7.6

Table A2.2 Deaths in 2020, years of life lost (YLLs), years lived with a disability (YLDs) and disability-adjusted life years (DALYs) attributable to tobacco use, by region (1000s)

Region	Deaths	% of total	YLLs	% of total	YLDs	% of total	DALYs	% of total
Established market economies	1 286	14.9	10 670	21.2	5 828	12.5	16 499	17.0
Former socialist economies	1 101	22.7	10 072	26.3	2 571	10.2	12 643	19.9
India	1 523	13.3	18 183	12.0	5 840	6.8	24 024	10.2
China	2 229	16.0	23 418	18.0	11 996	13.2	35 415	16.1
Other Asia and islands	681	8.8	7 475	7.7	2 587	3.7	10 061	6.1
Sub-Saharan Africa	298	2.9	3 945	1.7	1 512	1.6	5 457	1.7
Latin America and Caribbean	447	9.4	4 888	8.8	2 392	4.6	7 280	6.8
Middle Eastern crescent	817	12.3	9 477	9.2	2 823	4.4	12 299	7.3
World	8 383	12.3	88 129	10.3	35 549	6.7	123 678	8.9
Established market economies and former socialist economies	2 387	17.7	20 742	23.4	8 399	11.7	29 141	18.2
Demographically developing regions	5 996	10.9	67 386	8.7	27 150	5.9	94 537	7.7

Most risk factors for health act upon, or cause, a variety of diseases and injuries. Thus, cigarette smoking is a known or probable cause of more than 25 diseases, the most important being lung cancer, several other sites of cancer, heart disease, stroke, chronic bronchitis and emphysema. To estimate the total burden due to active smoking, it is highly desirable to begin by estimating the contribution of smoking to the burden of each individual disease, and then to sum these disease-specific contributions to arrive at an estimate of the overall burden of disease that can be attributed to smoking in a given region. In some cases, however, the proportion of a specific disease that can be attributed to a given risk factor may be so small that it cannot be reliably assessed. Nonetheless, if the risk factor acts on several diseases or injuries, its contribution to the overall disease burden may be significant. In such cases, it is preferable to base the assessment of burden on total mortality or morbidity, and not on the specific component diseases or injuries. A good example of this type of risk factor may be narcotic drug use.

2.2 Calculating the fraction of disease burden attributable to a risk factor

The basic method for assessing attributable burden involves three steps. The first is to estimate from case-control studies or from prospective epidemiological studies the relative risks of death or disability for individuals at different levels of exposure to the risk factor in question (such as alcohol). For example, the risk of death from alcohol is higher in those who drink very heavily than in those who drink moderately. In this particular case, the relative risk (RR) is the ratio of risk of death in individuals who have a certain number of drinks per day compared with the risk of death in individuals who do not drink at all.

In order to calculate RRs, a "reference level" of exposure must be set. This will vary according to the type of risk factor and could be (1) zero for the whole population, (2) a low value based on actual observed levels or (3) an arbitrary value. Because risk is being assessed at the level of whole populations, the reference value may be either a single level for the whole population, or a *distribution* at different values through a population.

An example of the use of the first type of reference level is for tobacco. *Any* use of tobacco in any form whatever *increases* the risk of disease and death. In this case, the appropriate reference group for calculating the relative risk of death from tobacco use would be lifelong non-users. For certain other risk factors, however, it is impossible to identify a group with zero exposure. An example of the second type is the measurement of water and sanitation as a risk factor. It is impossible to ensure that all people in a region have access to clean water and sanitation, even in industrialized countries. However, the population exposure to unsafe water in these coun-

tries is very low, and this low level of exposure could be used to define a reference distribution against which to compare other regions. An example of the third type of reference measure concerns the assessment of alcohol consumption as a risk factor. Research has consistently demonstrated that low levels of alcohol consumption are associated with decreased risk of death from some diseases compared with lifelong abstainers, but that mortality risks increase with increasing consumption beyond these low levels, in a so-called J-shaped curve. Thus, an appropriate arbitrary reference distribution in this case might be that found in a hypothetical population where consumption varies but no one consumes alcohol at harmful levels. Of course, it is unlikely that such a distribution would ever be found in practice. A simplified approach is to set a single arbitrary level for the entire population and assume that all individuals have that same level of exposure. For example, WHO recommended maximum levels of exposure to air pollutants may be used as the reference levels for computing relative risks from air pollution. Clearly, different reference levels or distributions are appropriate for different risk factors. This, together with differences in the methods for measuring exposure, makes comparisons of the burdens attributable to different factors a hazardous process to be undertaken with great caution.

Having calculated the RR, the second step in measuring the burden attributable to a given risk factor is to determine the distribution of the population according to different levels of exposure. For example, 20% of the population may be heavy smokers, whose RR of death from lung cancer might be 40 compared with lifelong non-smokers. Another 25%, for example, might be "medium" level smokers with a RR of 20, and another 15% might be light smokers with a RR of 10. The population-level relative risk is then calculated as a weighted average of the different RRs for different levels of exposure, weighted by the proportion of the population with the respective exposure level.

The third step is to calculate the burden that is attributable to the risk factor within that population. This is done by estimating what the levels of mortality or disability would be if the distribution of the population by exposure level were shifted to the reference distribution. For example, in the case of alcohol, the reduction in the risk of mortality or disability would be calculated by multiplying the proportion of the population at each level of harmful or hazardous consumption by the excess risk of death or disability that applies at that level. Summing up the excess at each level of harmful consumption yields an estimate of the burden of disease in that region that can be attributed to alcohol consumption.

2.3 Current and future impacts

It is extremely important to distinguish between the burden of disease and injury that arises from current (or

recent) exposure to a risk factor, for which current exposure levels are relevant, and that which arises from past exposure to a risk factor (for which past, and, to a lesser extent, recent, exposure levels are relevant). While it is possible to measure the proportion of the current disease burden that is attributable to past exposure, it is much less easy to assess the future burden that may result from current exposure. This is because the link between exposure to the risk factor and its consequent diseases may alter over time as a result of secular trends, socio-economic changes and advances in technology. The uncertainty is greatest where the time lag between exposure and disease is long. For some risk factors, such as unsafe water and sanitation, or blood alcohol levels, the time lag between exposure and disease is short, so the relationship between them is not likely to change much over a secular period. For others, however, such as tobacco, hypertension and the effects of childhood malnutrition on adult physiology, the time between exposure and disease may be greater. In the longer term, estimates of future burden are desirable for health policy-makers as a means for assessing priorities for risk reduction. Because of the uncertainties involved, however, we have assessed the projected impact on future disease burden of only one risk factor, tobacco. In this case, the future burden may be assessed with some confidence because it is more strongly dependent on current levels of exposure.

2.4 Methodological uncertainties and future research challenges

It is generally assumed that RRs do not vary greatly between populations. By contrast, the *distribution* of those risks does vary between populations, and differences in the total population burden between regions are most likely to be explained by differences in distribution. For example, the health hazards of drug use are likely to be similar in different regions of the world. However, the burden of disease and injury due to drug use will vary from region to region simply because of the types of drugs used and differences between regions in the proportions of men and women in different age groups who use them. Reliable data on the distribution of the selected risk factors are not yet available for all populations.

The available measures of exposure for many risk factors are imperfect. In most cases, the estimated relative risks of exposure are a function of the duration, intensity and type of exposure. Often, however, data are available only for the current levels of exposure, such as the proportion of the population who currently smoke, or the proportion who drank x units over the past two weeks. Current exposure is then used as a proxy for past cumulative exposure. A further problem is that even for current exposure levels, measurements of the entire population's exposure can rarely be obtained at any one time. When individuals can move rapidly between differ-

ent exposure states, as for example with alcohol consumption, it becomes extremely difficult to derive accurate measures of the average population distribution of exposure.

In the case of assessments of tobacco exposure, this problem has been overcome. Peto, Lopez et al. (1992) have estimated the cumulative past exposure to smoking by using lung cancer rates to estimate a smoking impact ratio (SIR). The SIR captures many aspects of smoking exposure, such as duration, quality, type and number of cigarettes. The effect of all these (and possibly other) factors associated with smoking are very well captured by the lung cancer death rate in most populations. Since lung cancer is extremely rare among lifelong non-smokers, knowledge about the level of lung cancer mortality in a region and the amount of that mortality which is attributable not to smoking but to "background" exposures such as radon or air pollution is then a very good indicator of the cumulative effect of smoking in a particular region. After subtracting the "background" level of lung cancer in non-smokers, the so-called modified lung cancer rate can then be used to estimate the proportion of other diseases which are also attributable to smoking. Thus, in populations where the incidence of lung cancer is low, it is likely that relatively little mortality from other causes, such as heart disease and chronic bronchitis, is attributable to smoking. In populations where the incidence of lung cancer is high (and non-smoker lung cancer rates are low), the converse is likely to be true.

Despite the various drawbacks and complications we have discussed, the pursuit of good data on the impact of various risk factors on population disease burden is recognized as an important step towards improving health policy. The evidence that risk reduction can be a highly cost-effective strategy for reducing disease burden (e.g. through tax disincentives on tobacco consumption) gives added impetus to this work. It is critical that the impact of risk factors on population health be quantified in the same way as diseases and injuries in order to inform the health policy debate and catalyse appropriate responses for the coming decades.

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Professor Christopher J. L. Murray has served as Chair of the WHO Tuberculosis Options Research Committee since 1992 and was Chair of Working Group I of the Ad Hoc Committee on Health Research Relating to Future Intervention Options Harvard Center for Population and Development Studies
Roger and Ellen Revelle Building
9 Bow Street
Cambridge, MA 02138
USA
tel: (1-617) 495-8498
fax: (1-617) 496-3227

Dr Alan D. Lopez is Director of the World Health Organization Programme on Substance Abuse
World Health Organization
20, Avenue Appia
CH-1211 Geneva 27, Switzerland
tel: (41-22) 791-2374
fax: (41-22) 791-4851